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*Primarily that of the Prairie States*

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# The American Midland Naturalist

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JULY, 1934

No. 4

## THE AMPHIBIANS OF KANSAS

HOBART M. SMITH

### Introduction

The present work has largely as its object the bridging of the gap in the knowledge of the amphibians of the central plains region. For this reason, it is largely taxonomic and distributional, but, so far as possible, in most cases, complete life history, based upon published accounts and upon observations of my own and of associates, have been presented for each species. There are numerous features of the life histories of many of the amphibians of the state which are yet to be observed, and these are made known to the future worker, who may thus avoid unnecessary duplication of previous investigations.

The need for such a compilation is obvious. Twenty years or more have passed since faunal reports of adjacent states have appeared. Ellis and Henderson briefly summarized the amphibians of Colorado in 1913, and Hurter published his Herpetology of Missouri in 1911, but the scientific terminology of neither of these is the same as that employed at present. The life histories there presented are far from complete as now known, and the one dealing with the western fauna has long been out of print. Neither includes discussions of all of the amphibians of the area between them, as the fauna of the latter is a composite of southern as well as of eastern and western species. The herpetology of Oklahoma, although admirably treated so far as snakes and lizards are concerned, is as yet not sufficiently well known as regards amphibians to be of value to the student in Kansas. For comprehensive works, therefore, the student must refer to Cope's monograph of 1889, or Dickerson's Frog Book of 1906, in order to determine his material. The difficulties of then determining the correct status of the taxonomic appellations concerned are almost insurmountable except by detailed study, aided only by the check-list by Stejneger and Barbour.

In most cases no attempt has been made to present a complete synonymy, as that is beyond the scope of this work. If complete synonymies are available elsewhere, references are given to them.

The museum collections which I have examined are those of Kansas State College at Manhattan, Ottawa University and the University of Kansas. Specimens from these museums are designated by KSC, OU and KU

respectively. From various individuals, particularly Mr. H. K. Gloyd and Dr. Charles E. Burt, I have received data on specimens in other museums: University of Michigan Museum of Zoology (UMMZ); U. S. National Museum (USNM); Museum of Comparative Zoology at Harvard College (MCZ); Museum of Vertebrate Zoology of the University of California (MVZ); California Academy of Sciences (CAS); British Museum of Natural History (BMNH); Field Museum of Natural History (FMNH). Specimens in the private collections of Dr. Edward H. Taylor, Dr. C. E. Burt, Mr. H. K. Gloyd, Mr. David H. Dunkle, Mr. C. W. Hibbard and myself are designated by EHT, CEB, HKG, DHD, CWH and HMS respectively. The number in parentheses after a catalogue number indicates the number of specimens, if more than one, so catalogued; when the specimens are uncatalogued or the catalogue number is not known, merely the number of specimens is given. Catalogue numbers of skeletons are italicized.

Measurements are given in millimeters unless otherwise stated. And, unless otherwise stated, the measurements are taken in the manner described by Storer (1925, pp. 26-27), except in one point—the length of the head is taken from the tip of the snout to the middle of a line between the angles of the jaws. Only typical specimens have been selected for measurement. Unless otherwise stated they are from Kansas. In certain cases an attempt has been made to show geographical variation, if any, by measurements of individuals from various localities.

#### Acknowledgments

The adoption of this problem and the completion of it is due primarily to the continued interest and aid afforded by my major professor, Dr. Edward H. Taylor. My most sincere appreciation of his efforts is here expressed. For further aid, I am deeply indebted in particular to Mr. H. K. Gloyd and Dr. Charles E. Burt, both of whom have been exceedingly generous with distributional data from their personal collections, and with other material of importance. The frequently sought advice of Dr. E. R. Dunn has been of very material aid in a number of important points, and Mr. M. Graham Netting has carefully examined some of the *Bufo woodhousii* and *americanus*. Mrs. Helen T. Gaige and Dr. Leonard Stejneger have very kindly loaned or given information concerning specimens in the museums with which they are associated. For innumerable courtesies with regard to the material in the Dyche Museum of Natural History, upon which this study is largely based, I am greatly indebted to Mr. C. D. Bunker, curator. Dr. H. H. Lane has made it possible to include photographs of most of the species of amphibians in the state, has made available all necessary laboratory equipment for this study and has frequently offered valuable advice with regard to the manuscript, for which I wish to express my deepest appreciation. Among others to whom I am indebted for assistance in various ways may be mentioned Dr. W. J. Baumgartner, of the Department of Zoology of Kansas University; Dr. R. K. Nabours, Dr. M. J. Harbaugh and Dr. R. H. Painter of Kansas State College at Manhattan; Mr. L. A. Brennan of Hays, Kansas; Mr. S. L. Loewen of Sterling, Kansas; Mr. R. H. Kingman of Wash-

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#### History of Kansas Batrachology

Kansas did not exist until 1854, when it was first organized as a territory. Its north, east and south boundaries were then as they are today, but the western boundary extended to the crest of the Rocky Mountains. Even before becoming a territory, the amphibians of the state to be were rapidly being described—13 were already described, and two more (*Bufo punctatus* and *Rana areolata*) were described in the year of organization. Within the next three years five more species (*Ambystoma texanum*, *A. tigrinum mavortium*, *Bufo debilis*, *Bufo woodhousii* and *Gastrophryne olivacea*) were described, and *Scaphiopus bombifrons* was recognized shortly after, in 1864. The remaining four species, all salamanders, were described from 30 to 50 years later, the most recent being *Triturus viridescens louisianensis* (1914).

Only two of these species have been described from Kansas—*Hyla crucifer* and *Gastrophryne olivacea*—the first long before Kansas existed, even as a territory. The type locality of the former, fortunately, was far more exactly stated than usual, in the early descriptions, and enabled later students to place it even to county (Cantonment Leavenworth). The difficulty encountered due to the lack of a clearly stated type locality is exemplified in *Gastrophryne olivacea*, whose type locality reads "Kansas and Nebraska," a region which, at the time of the description, extended from the southern border of Kansas to Canada and west to the Rocky Mountains. In all likelihood the type specimens came from Kansas, for no recent authorities have found it farther north or west, but this is mere speculation.

The description of the species was the least of the effort necessary to indicate the extent of the batrachological fauna of the state—in fact, *Hyla crucifer* was the only species known to exist there in 1854. It was the work of numerous collectors and scribes to add further species to the list. Edward Hallowell was the first contributor, publishing two papers in 1857 on the herpetology of Kansas, based upon specimens collected by Dr. Hammond, who was evidently stationed at the army post at Fort Riley. Unfortunately, the first paper gave no more definite localities for the specimens than the title indicated—"Kansas and Nebraska," so that the entire series of records on the six species are doubtful so far as Kansas is concerned. In the second paper in the same volume, written very much like an appendix to another article, Hallowell mentions two species (*Bufo w. woodhousii* and *Ambystoma tigrinum mavortium*) definitely from Fort Riley. Both of these were among the six mentioned in the previous paper, leaving four species doubtfully reported from Kansas, to be verified by later writers (*Acris gryllus*, *Rana catesbeiana*, *Rana pipiens* and *Gastrophryne olivacea*).

For a number of years nothing new appeared so far as the amphibians of the state are concerned, until in 1879 Coues and Yarrow remarked incidentally



that specimens of *Pseudacris triseriata* were in the U. S. National Museum from Kansas.

A third contributor, by far the most important so far as amphibians are concerned, was Cragin, who presented his "Preliminary Catalogue of Kansas Reptiles and Batrachians" in 1881. In this all species of Hallowell's first paper (1857a) were verified, except *Gastrophryne olivacea*, which Cragin called *Engystoma carolinense*, obtaining the locality record from "Hallowell." Quite likely he had seen no specimens of it, but evidently assumed that Hallowell's single specimen was from Kansas. Twelve species, eliminating synonymized names, are recorded in this paper by Cragin. Among these there is but one (*Spelerpes ruber* = *Pseudotriton ruber ruber*) which has since been eliminated. "This was based upon an incorrect statement of the range in Jordan's Manual of the Vertebrates." (Dunn, 1926, p. 281) The species has actually never been found east of the Mississippi River. His record of *Ambystoma maculatum* is likewise not acceptable, having been based upon the same authority as the record of *Pseudotriton*, although the species actually exists in the state as shown in this paper. Thus, six species previously unrecorded or doubtfully recorded were definitely added: *Ambystoma texanum*, *Bufo cognatus*, *Acris gryllus*, *Hyla v. versicolor*, *Rana pipiens* and *R. catesbeiana*. A total of ten species were then known positively from Kansas, with no doubtful records except *Gastrophryne*. In the hypothetical list at the end of his paper, Cragin has six species: *Rana clamitans*, *Spea* (= *Scaphiopus*) *bombifrons*, *Amblystoma* [sic] *obscurum* (= *Ambystoma tigrinum*), *Amblystoma opacum*, *Menopoma alleganiensis* (= *Cryptobranchus alleganiensis*), and *Necturus lateralis* (= *N. maculosus*). All but two of these (*Cryptobranchus alleganiensis*, which occurs, according to Stejneger and Barbour (1923) in "Western New York, the Great Lakes System, Iowa and southward to Georgia and Louisiana"; and *Ambystoma opacum*, which is found as far west as eastern Missouri and Arkansas) have been either synonymized or later actually recorded from the state. One of these species (*Necturus*) he reported in his next paper (1885). He also recorded a specimen of *Ambystoma texanum* from Woodson county, verifying Jordan's report of the species from "Kansas." This paper, published in the Bulletin of the Washburn College Laboratory of Natural History, reappeared almost verbatim the same year in the Transactions of the Kansas Academy of Science.

Cragin's last contribution was in 1894, when he reported *Bufo debilis* from Kansas for the first time.

Cragin's second paper was preceded two years by Yarrow's check list of North American reptiles and batrachians of 1883, in which were recorded seven species from Kansas, none of them new. His *Bufo americanus*, which would be new if acceptable, was based apparently upon *w. woodhousii*. Cope soon followed Yarrow with his monographic "Batrachia of North America" of 1889. Seven species were recorded; only two were reported as new: *Eurycea multiplicata* and *Bufo compactilis*. Regarding the former, Cope states "Professor Cragin sent me a specimen which was taken in southern Kansas, . . ." Although Dunn, who examined practically all important col-

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lections in the United States in preparation for his monograph of 1926, found no trace of the specimen Cope mentioned, and although they are not in any Kansas collection which I have examined, records of this species nearby in adjacent states and the reliability of the authorities concerned with the Kansas specimen, are sufficient for the acceptance of Cope's report. The *Bufo compactilis* record, based supposedly upon two specimens in the U. S. National Museum, catalogue number 4994, from "Kansas," collected by R. Kennicott, is, according to Dr. Stejneger, whom I have consulted, quite erroneous. The catalogue number is of a *Eumeces*. Since Kansas is far beyond the northern limits of the range of the toad as now known (Southwestern Utah and eastern Arizona east through southern New Mexico, central and western Texas, and southeastern Oklahoma), the record is not considered.

These earlier records seem largely to be due to the activities of certain army and Railroad Survey Doctors, such as W. A. Hammond and J. G. Cooper, who placed collections with both the Philadelphia Academy of Natural Sciences and the U. S. National Museum. Other names such as Robert Kennicott, H. Berendt, Edward Palmer, Charles Ruby and William S. Wood are associated with other U. S. National Museum specimens. Certainly the early professors of Kansas schools contributed much to the knowledge of the amphibians of the state, particularly Cragin, Popenoe and Snow.

Frank A. Hartman connects the biologists of 1850-1890 with those of recent date. His work in various parts of the state is made apparent by the frequent appearance of his name as collector of specimens in the Dyche Museum. In 1906 he published an account of the food of the Kansas batrachians, and reported one species new to the state—*Rana areolata*—from near Lawrence.

It was not until 1923 that anything but incidental Kansas records of amphibians appeared. In 1918 Fowler and Dunn reported specimens of *Ambystoma tigrinum* from Kansas, and Dunn (1918) later reported the same species from Kansas on the basis of specimens in the Museum of Comparative Zoology at Harvard. In 1920 Boulenger reported *Rana pipiens* from Douglas county. At the end of 1922, 14 species of amphibians were definitely recorded from Kansas. Dice, in 1923, mentioned four species of amphibians from Riley county, of which one (*Gastrophryne*) is a verification of Hallowell's doubtful report of 1857 (a). This paper marks the beginning of a series of numerous publications on Kansas batrachology. Dr. Charles E. Burt is perhaps the second of this series, contributing probably the most of all. His list of the reptiles and amphibians of Riley county mentions seven species of the latter, none new. His *Hyla phaeocrypta* record from Riley county (1928) is here considered as *Hyla versicolor versicolor*. In his succeeding papers (1931b, 1932, 1933; and May Danheim Burt, 1929a, b, c) seven species are recorded from various localities, although none were new. Linsdale (1927) reported seven species from Doniphan county, none of which were new. The first new state record after Dice's was furnished by Gloyd in 1928 in a report on the amphibians and reptiles of Franklin county, in which nine species of the former were reported, that of *Bufo americanus* being the first authentic state report. The same author mentions another amphibian

(*Bufo cognatus*) from Riley county (not a new state record) in 1929, and in 1932 published another county report (Miami) in which another species (*Triturus viridescens*) is reported from the state for the first time. The interest in the eastern part of the state exhibited by these authors and certain later ones was paralleled by the work of Taylor and his students in Morton county, which terminated with the addition of two new state records: *Scaphiopus bombifrons* by Taylor in 1929, and *Bufo punctatus* by Hill in 1931. In 1932 four new forms were reported by myself (*Eurycea melanopleura*, *Typhlotriton spelaeus*, *Rana clamitans* and *Rana palustris*) from the southeastern corner of the state, as a result of the work of Dr. Taylor and several students aside from myself. Two new reports are given in this paper (*Ambystoma maculatum* and *Pseudacris clarkii*). One of these, *Ambystoma maculatum*, is a verification of the purely hypothetical record presented by Cragin in 1881 as authentic.

Wright has contributed also to the knowledge of the distribution of Kansas amphibians in his work on the frogs of the Okefinokee Swamp, Georgia (1931), mentioning *Acris gryllus* from Emporia and Lawrence.

#### Taxonomic and Distributional Discussion

The number of species and subspecies of amphibians in Kansas dealt with in this report has been reduced somewhat from the actual number reported or represented in museum collections. The eliminated species are as follows:

1. *Pseudotriton ruber ruber*. A state report by Cragin (1881), based upon an incorrect representation of the range in Jordan's Manual of the Vertebrates.

2. *Bufo compactilis*. A report by Cope (1889) based upon two specimens in the U. S. National Museum. The specimens cannot now be found, and the state is far from the known range of the species.

3. *Bufo valliceps*. A single specimen is in the Dyche Natural History Museum, purporting to be from Gove county, collected during July, 1910, by the Kansas University Biological Survey. This is undoubtedly an erroneous record, as *valliceps* has never been reported from farther north than Texas.

4. *Hyla phaeocrypta*. Recorded as a state record by Burt in 1928. This is probably *Hyla versicolor*, and is so considered here.

With the elimination of these species, a hypothetical list may be constructed:

1. *Ambystoma annulatum*. Found frequently on the Ozark Plateau, and recorded from as near Kansas as Stone county, southwestern Missouri (Noble and Marshall, 1929). This is evidently an Ozark Plateau species, and might easily be expected in southeastern Kansas, into which the Plateau extends.

2. *Eurycea lucifuga*. Dunn (1926, pp. 342-343) records this also on the Ozark Plateau, from as near Kansas as Barry and Stone counties, southwestern Missouri. Ortenburger (1929b) has found it in northeastern Oklahoma (Delaware county) also. Its presence in Kansas is still more strongly indicated by the fact that Dr. Taylor collected, a number of years ago, a salamander near Baxter Springs, Cherokee county, which he recalls as being very

reddish. This is characteristic of *lucifuga* in life, and of no other, so far as I am aware, in that area. The specimen was unfortunately accidentally destroyed.

3. *Plethodon glutinosus*. Recorded from near Kansas in Stone county, Missouri, and Carroll county, Arkansas (Dunn, 1926, p. 142).

4. *Plethodon cinereus*. Recorded from near Kansas in Stone and Chadwick counties, southwestern Missouri, and Benton county, Arkansas, by Dunn (1926, p. 179).

5. *Scaphiopus holbrookii*. Ortenburger and Freeman (1930) report *Scaphiopus holbrookii* from Cimarron county, Oklahoma, very near the Kansas border.

6. *Rana sylvatica*. Hurter (1911) records this from Stone county, Missouri, and Black (1933) recorded a specimen from northeastern Kansas. It quite possibly occurs in extreme southeastern Kansas.

With regard to the species retained in the Kansas list, a few taxonomic changes are proposed. They are:

1. *Scaphiopus bombifrons* is given full specific status, instead of subspecific.

2. *Bufo woodhousii woodhousii* is considered as a subspecies related to *fowleri*.

Further, the range of *Triturus viridescens louisianensis* is considerably enlarged by the recognition of the Kansas form as of that subspecies, instead of *v. viridescens*.

The resurrection of *Gastrophryne olivacea* and the placing of *texensis* into its synonymy has been previously noted (in press).

The number of amphibians in Kansas is so small that but little light is cast upon the life zones as they exist within the state. However meager the data are, they nevertheless clearly show that the physiographic regions (Fenneman, 1928) are far more nearly paralleled by distributional facts than are the life zones as depicted by Merriam (1898). According to the former, the state may be analyzed as follows:

A. Interior Plains—includes all but extreme southeastern Kansas.

I. Central Lowland—Kansas east of a more or less diagonal line from the southern border, near Medicine Lodge to the northern border near the Washington-Republic county line.

a. Dissected Till Plains—northeastern Kansas in the glacial region.

b. Osage Plains—eastern Kansas south of glacial region.

II. Great Plains Province—Kansas west of I.

a. High Plains—the flat high plains of the western fifth of Kansas.

b. Plains Border—"The eroded margin of the Great Plains which is elsewhere narrow and included in the High Plains, but greatly expanded in Kansas." (Fenneman, 1928, p. 283).

B. Interior Highlands—includes extreme southeastern Kansas.

I. Ozark Plateaus.

The Ozark Plateaus province is clear enough as *Eurycea melanopleura*, *Typhlotriton spelaeus*, *Eurycea multiplicata*, and *Rana palustris* are at present known to be confined to that region in Kansas. Others will no doubt be found later.

However the Central Lowlands seem to exist as a single entity, the phy-

siographical subdivisions here being of no ecological importance. *Ambystoma texanum*, *Necturus maculosus*, *Bufo americanus*, *Hyla versicolor versicolor*, *Rana areolata* and *Gastrophryne olivacea* are more or less characteristic of this province. *Ambystoma maculatum*, *Triturus viridescens louisianensis* and *Hyla crucifer* seem to be confined to a much more narrow eastern area than is physiographically indicated.

*Scaphiopus bombifrons* and *Bufo cognatus* belong to the Great Plains province, which again cannot be further subdivided on the basis of distribution, however different it may be physiographically. Two species (*Bufo debilis* and *B. punctatus*) seem to be restricted to the southwestern corner of the state, belonging to a Sonoran fauna which does not extend so far north as the physiographic divisions. Temperature here controls distribution while physiography does not.

The only species which seems to be derived directly from the south is *Pseudacris clarkii*. It is a striking fact that all of the remainder are either eastern or western in their derivation. Southern elements apparently reach their maximum northward migration in Oklahoma.

In conclusion, it may be stated that with regard to amphibians in Kansas, the more important of the Physiographic regions, the Major Divisions and Provinces, are sufficiently important that distribution is more or less controlled by them, while the lesser subdivisions, the Sections, are of little importance in effect upon distribution and are second to ecological conditions not greatly affecting physiographic conditions.

#### A Systematic List of the Amphibia of Kansas

Class AMPHIBIA

Order CAUDATA

Suborder AMBYSTOMOIDEA

Family Ambystomidae

1. *Ambystoma maculatum* (Shaw)
2. *Ambystoma texanum* (Matthes)
3. *Ambystoma tigrinum mavortium* (Baird)

Suborder SALAMANDROIDEA

Family Salamandridae

4. *Triturus viridescens louisianensis* (Wolterstorff)

Family Plethodontidae

5. *Eurycea melanopleura* (Cope)
6. *Eurycea multiplicata* (Cope)
7. *Typhlotriton spelaeus* Stejneger

Suborder PROTEIDA

Family Proteidae

8. *Necturus maculosus maculosus* (Rafinesque)

Order SALIENTIA

Suborder ANOMOCOELA

Family Pelobatidae

Subfamily Pelobatinae



9. *Scaphiopus bombifrons* Cope
  - Suborder PROCOELA
  - Family Bufonidae
  - Subfamily Bufoninae
10. *Bufo americanus americanus* (Holbrook)
11. *Bufo cognatus* Say
12. *Bufo debilis* Girard
13. *Bufo punctatus* Baird and Girard
14. *Bufo woodhousii woodhousii* (Girard)
  - Family Hylidae
  - Subfamily Hylinae
15. *Acris gryllus* (Le Conte)
16. *Pseudacris clarkii* (Baird)
17. *Pseudacris triseriata* (Wied)
18. *Hyla crucifer* Wied
19. *Hyla versicolor versicolor* (Le Conte)
  - Suborder DIPLASIOCOELA
  - Family Ranidae
  - Subfamily Raninae
20. *Rana areolata* Baird and Girard
21. *Rana catesbeiana* Shaw
22. *Rana clamitans* Latreille
23. *Rana palustris* Le Conte
24. *Rana pipiens* Schreber
  - Family Brevicipitidae
  - Subfamily Microhylinae
25. *Gastrophryne olivacea* (Hallowell)

#### Key to the Adults of Kansas Amphibia

- A1. Tail present; legs approximately equally developed.
  - B1. Four toes on both anterior and posterior limbs; eyelids absent; external gills present throughout life.—*Necturus maculosus maculosus* (Rafinesque)
  - B2. Five toes on posterior limbs; external gills absent in adults.
    - C1. Cranial carinae present; costal grooves indistinct or absent; teeth consisting of a median double vomero-palatine series between orbits and extending forward to between posterior borders of choanae; a dorsal and ventral caudal fin in aquatic adults.—*Triturus viridescens louisianensis* (Wolterstorff)
    - C2. Cranial carinae absent; costal grooves present; teeth consisting of a vomerine series and in some forms also of a parasphenoid group; no dorsal or ventral tail fins.
      - D1. Naso-labial groove present; parasphenoid teeth present.
        - E1. Vomerine and parasphenoid teeth continuous; 16-17 costal grooves; normally blind.—*Typhlotriton spelaeus* Stejneger.
        - E2. Vomerine and parasphenoid teeth separate; costal grooves 13-14 or 20; eyes functional.
          - F1. Costal grooves 20.—*Eurycea multiplicata* (Cope)
          - F2. Costal grooves 13-14.—*Eurycea melanopleura* (Cope)
      - D2. Naso-labial groove absent; parasphenoid teeth absent.

- E1. Vomerine teeth not extending laterally beyond nares, in two median series; color uniform grayish or bluish above (brownish in some preserved specimens), lighter below; no distinctly outlined light spots above.—*Ambystoma texanum* (Matthes)
- E2. A second, lateral series of vomerine teeth, extending laterally beyond nares.
  - F1. One plantar tubercle; spots circular, occasionally somewhat elongate; belly immaculate.—*Ambystoma maculatum* (Shaw)
  - F2. Two plantar tubercles; spots, for the most part, elongate, especially laterally, some passing onto the ventral surface, which is usually more or less spotted or blotched; color pattern of specimens transformed in captivity more distinctly barred.—*Ambystoma tigrinum mavortium* (Baird)
- A2. Tail absent; hind legs much better developed than fore legs and adapted to leaping.
  - B1. Distinct parotid glands present behind eyes; no teeth in upper jaw.
    - C1. Cranial crests absent, or, if present, indistinct and very closely approximated to eyes, forming a narrow border about them; maximum length not over 75 mm.
      - D1. Parotid glands round; color brownish or greenish in life; tips of warts reddish.—*Bufo punctatus* Baird and Girard
      - D2. Parotid glands more or less triangular,  $1\frac{1}{2}$  to 2 times as long as broad, more or less triangular, lateral median portion extending onto sides; color greenish or grayish in life, with black and white spots or reticulations on back.—*Bufo debilis* Girard
    - C2. Cranial crests distinct, and not confined to a narrow border about eyes.
      - D1. Cranial crests uniting to form a conspicuous boss in nasal region; pattern of large, rather closely approximated, distinctly outlined and light-edged spots, sometimes elongated so as to form a reticulated pattern.—*Bufo cognatus* Say
      - D2. Cranial crests not united to form a conspicuous boss in nasal region; spots usually small, covering but three or four warts, and when large, not distinctly outlined.
        - E1. Chest with numerous dark spots; parotid glands broad, usually less than twice as long as broad; median dorsal light line rarely present, and, when present, irregular in outline; second subarticular tubercle of fourth toe frequently divided, the first seldom not divided; snouts of males distinctly pointed in lateral profile; song a high trill of 20-30 seconds.—*Bufo americanus americanus* (Holbrook)
        - E2. Chest immaculate or with a single median dark spot; parotid glands narrow, usually more than twice as long as broad; a median dorsal light line always present; second subarticular tubercle of fourth toe never divided, first but seldom; snouts of both males and females truncate; song a low trill of 3-4 seconds.—*Bufo woodhousii woodhousii* (Girard)
- B2. No distinct parotid glands present; teeth present or absent (*Gastrophryne*) in upper jaw.
  - C1. Toes not or but slightly webbed, not more than the proximal phalanx of the fourth toe webbed; discs on toes, if present, not nearly half the size of tympanum.
    - D1. Tympanum absent; head pointed, very narrow; intercalary cartilages between phalanges absent; no teeth in upper jaw.—*Gastrophryne olivacea* (Hallowell)

- D2. Tympanum distinct; intercalary cartilages present between phalanges; teeth present in upper jaw.
- E1. Usually a triangular dark mark between eyes; tympanum very nearly in contact with angle of jaw; pattern always of rather large, dark spots placed irregularly on back; tibio-tarsal articulation extending forward to orbit or between orbit and tympanum; width of head entering length from snout to vent 3.0 to 3.2 times; no, or only an indistinct, dark line bordering upper jaw.—*Pseudacris clarkii* (Baird)
- E2. The triangular dark mark between eyes usually absent; tympanum distinctly separated from angle of jaws; pattern usually of stripes, these sometimes broken up into rows of spots; tibio-tarsal articulation extending forward usually to between axilla and tympanum; width of head entering length from snout to vent 3.3 to 4.0 times; usually a distinct dark line bordering upper jaw.—*Pseudacris triseriata* (Wied)
- C2. Toes distinctly webbed, no more than three terminal phalanges of fourth toe free.
- D1. An enlarged, blackened inner metatarsal tubercle with a free cutting edge present; pupil of eye vertical.—*Scaphiopus bombifrons* Cope
- D2. No enlarged, blackened metatarsal tubercle present; pupil of eye round.
- E1. Enlarged disks half the diameter of tympanum, or larger, present on tips of longest digits.
- F1. General color greenish, slate or gray; no distinct cruciform mark on back; webs between toes extending to terminal disks (except on fourth).—*Hyla versicolor versicolor* (Le Conte)
- F2. General color brownish; a distinct, narrow-lined cruciform mark on back; webs between toes extending to penultimate phalanges (except on fourth).—*Hyla crucifer* Wied
- E2. No enlarged disks about half the diameter of tympanum, or larger, present on tips of digits.
- F1. No dorso-lateral dermal folds present.
- G1. Skin on ventral surface of belly smooth; tympanum distinct; no triangular dark mark between eyes; toes usually fully webbed, no more than the terminal phalanx of fourth toe free; intercalary cartilages between phalanges absent.—*Rana catesbeiana* Shaw
- G2. Skin on ventral surface of belly granular; tympanum indistinct; a triangular dark mark present between eyes; two phalanges of fourth toe free from web; intercalary cartilages between phalanges present; size not over 35 mm.—*Acris gryllus* (Le Conte)
- F2. Dorso-lateral dermal folds present.
- G1. Dorso-lateral folds terminating at sacrum; no distinctly outlined dark spots on back.—*Rana clamitans* Latreille
- G2. Dorso-lateral folds continuing to insertion of hind legs; distinctly outlined dark spots present on back.
- H1. Pattern of square or more or less rectangular spots in two rows between dorso-lateral folds, and in two lateral rows; dorso-lateral folds broad; concealed surfaces of thighs and groin orange (in life).—*Rana palustris* Le Conte
- H2. Pattern not of square or rectangular spots; concealed surfaces of thighs and groin not orange.
- I1. No markings on dorsal and lateral surfaces between spots; dorso-lateral folds usually narrow.—*Rana pipiens* Schreber
- I2. Dorsal and lateral surfaces between spots distinctly reticulated with darker; dorso-lateral folds usually broad; males with large external vocal sacs.—*Rana areolata* Baird and Girard

## A Key to the Known Larvae of Kansas Amphibia

- A1. External gills present throughout larval life; both limbs approximately equally developed; head distinct from body.
  - B1. A dorsal fin fold on body as well as tail.
    - C1. Mandible not corneous, blackened; 13-14 costal grooves.—*Triturus viridescens louisianensis* (Wolterstorff)
    - C2. Mandible corneous, blackened.
      - D1. 14 costal grooves; a lateral light line from eye to gills and from gills to side of tail; young larvae with about six dorsal crossbars on body, about four on tail.—*Ambystoma texanum* (Matthes)
      - D2. 11-12 costal grooves; no stripes on body.
        - E1. Costal grooves 11.—*Ambystoma maculatum* (Shaw)
        - E2. Costal grooves 12.—*Ambystoma tigrinum mavortium* (Baird)
  - B2. No dorsal fin fold on body.
    - C1. Skin continuous over eyes.
      - D1. Four digits on posterior limbs.—*Neoturus maculosus maculosus* (Rafinesque)
      - D2. Five digits on posterior limbs.—*Typhlotriton spelaeus* Stejneger
    - C2. Skin not continuous over eyes—eyelids present.
      - D1. Costal grooves 20.—*Eurycea multiplicata* (Cope)
      - D2. Costal grooves 13-14.—*Eurycea melanopleura* (Cope)
- A2. External gills absent (except during the first week or so after hatching); hind limbs developed long before fore limbs, latter appearing a short time before transformation; head not distinct from body.
  - B1. Mouth disk absent; spiracle median, near anus—*Gastrophryne olivacea* (Hallowell)
  - B2. Mouth disk present; spiracle sinistral.
    - C1. Upper mandible with a large median beaklike projection, lower mandible with a deep, elevated median notch; a black, corneous toothlike projection from roof of mouth; buccal musculature conspicuous and visible through skin, as viscera.—*Scaphiopus bombifrons* Cope.
    - C2. No notches or breaks on mandibles; no toothlike projection from roof of mouth.
      - D1. Papillary fringe confined to sides of labiae.
        - E1. Papillae confined to the lateral margin of the lower labium, or a slight marginal row of 4 to 6 papillae on upper labium; usually no inner papillae.—*Bufo punctatus* Baird and Girard
        - E2. Papillae on both upper and lower halves of lateral labial margin; some inner papillae.
          - F1. A distinct median space present in the inner row of teeth of the upper labium, usually contained 1-2 times in either lateral row.—*Bufo americanus americanus* (Holbrook)
          - F2. No distinct median space present in the inner row of teeth of the upper labium, the division between the lateral rows scarcely discernible.—*Bufo debilis* Girard (?)
      - D2. Papillary fringe encircling at least lower labium.
        - E1. Papillary fringe emarginate on sides; tadpoles 50-140 mm. in length.
        - F1. Viscera plainly visible through skin (in preserved specimens); tadpoles 74-84 mm., transforming during the first season.
          - G1. Median space of inner row of teeth in upper labium 2 to 4 times the length of either lateral part.—*Rana palustris* Le Conte

- G2. Median space of inner row of teeth in upper labium 1.0 to 1.5 times the length of either lateral part.—*Rana pipiens* Schreber
- F2. Viscera not plainly visible through skin; tadpoles 84-140 mm., wintering over one season.
- G1. Median space of inner row of teeth in upper labium usually less than the length of either lateral part; tadpoles to 140 mm., transforming size 43-59 mm.—*Rana catesbeiana* Shaw
- G2. Median space of inner row of teeth in upper labium 6-11 times the length of either lateral part.—*Rana clamitans* Latreille.
- E2. Papillary fringe not emarginate on sides; tadpoles 23-50 mm.
- F1. Median space of inner row of teeth in upper labium about equal to the length of either lateral part; teeth regularly 2/2; spiracular tube in life stands out at an angle from the body and the opening is apart from the body proper.—*Acris gryllus* (Le Conte)
- F2. Median space of inner row of teeth in upper labium 1/2 to 1/5 the length of either lateral portion; teeth usually 2/3; spiracular tube in life closely applied to body, opening not separated from latter.
- G1. Labial teeth usually 2/3, rarely 2/2; if 2/3, outer row of teeth in lower labium less than the length of the mandibles.—*Hyla crucifer* Wied
- G2. Labial teeth regularly 2/3; outer row of teeth in lower labium about twice the length of mandibles.—*Hyla versicolor versicolor* (Le Conte)

#### A Key to the Known Eggs of Kansas Amphibia

- A1. Eggs deposited singly, or in small groups up to six or seven; not deposited in contiguous masses of 20 or more.
- B1. Deposited in groups of 60 to 140 on the lower surfaces of objects such as boards, rocks, etc., below the surface of the water; envelopes three; individual eggs oval (supported in water), greater diameter about 14 mm., lesser about 11 mm.—*Necturus maculosus maculosus* (Rafinesque)
- B2. Not deposited in large groups, and not concealed under objects; outer envelope usually not over 7.5 mm.
- C1. Envelope single.
- D1. Envelope 1.2 mm. to 2.0 mm.—*Hyla crucifer* Wied
- D2. Envelope 2.3 mm. or more.—*Acris gryllus* (Le Conte)
- C2. Envelopes at least two.
- D1. Outer envelope about 4.0 mm.; vitellus about 2.0 mm.—*Ambystoma texanum* (Matthes)
- D2. Outer envelope about 7.5 mm.; vitellus about 3.0 mm.—*Ambystoma tigrinum mavortium* (Baird)
- A2. Eggs deposited in contiguous masses.
- B1. Egg mass in the form of files or bands.
- C1. A single outer tubular membrane present.—*Bufo woodhousii woodhousii* (Girard)
- C2. An inner tubular membrane present, and a partition between each egg.—*Bufo americanus americanus* (Holbrook)
- B2. Masses not in the form of files or bands.
- C1. Egg mass deposited on surface of water.
- D1. Inner envelope absent, mass usually over a foot in diameter.—*Rana catesbeiana* Shaw
- D2. Inner envelope present; mass rarely a foot in diameter.



- E1. Masses small, containing usually no more than 30-40 eggs, not more than 4 or 5 inches in diameter.—*Hyla versicolor versicolor* (Le Conte)
- E2. Masses larger, five by seven inches or larger—*Rana clamitans* Latreille
- C2. Egg mass not in the form of a surface mass or film; submerged.
- D1. Egg mass in the form of a small, loose cylinder about stems of grass, etc.; vitellus 0.9 to 1.2 mm.—*Pseudacris triseriata* (Wied)
- D2. Egg mass not in the form of a loose cylinder.
- E1. Egg mass a small cluster of not over 150 eggs, firm and compact.—*Ambystoma maculatum* (Shaw)
- E2. Egg mass large, containing 2000 eggs or more.
- F1. Eggs brown above and yellow below; mass a firm and regular globular cluster.—*Rana palustris* Le Conte.
- F2. Eggs black above and white below; mass a plinth.
- G1. Vitellus not over 2.0 mm., average 1.7 mm.; outer envelope about 3.5 mm.; black of animal pole distinctly separated from light vegetative pole.—*Rana pipiens* Schreber
- G2. Vitellus 2.46 to 2.5 mm.; outer envelope 4.5 to 5.0 mm. in diameter; black of animal pole encroaching upon the light vegetative pole.—*Rana areolata* Baird and Girard

#### Discussion of Species

##### *Ambystoma maculatum* (Shaw)

##### SPOTTED SALAMANDER

- Lacerta maculata* Shaw (1802, p. 304).
- Ambystoma punctatum* Cope (1867, pp. 175-177). An excellent description.
- Cragin (1881, p. 119). Recorded from Kansas after Jordan (Manual of Vertebrates).
- Cope (1889, pp. 56-60, 7 figs.). A complete description.
- Smith, B. G. (1907, pp. 381-385, 1 fig.). Description of spermatophores, spermatozoa and eggs, with an interesting discussion of phylogenetic significance of the method of breeding.
- Wright (1908, pp. 384-389). Discussion of first appearance; first record of embrace; discussion of various points in the life history.
- Wright and Allen (1909, pp. 687-692). Description of courtship and spermatophores and deposition of latter; remarks concerning egg complements and first appearance.
- Pope, P. H. (1916, p. 35). Records an adult found crawling on snow on a warm winter day (42° F.) preceded by a warm rain the night before.
- Ambystoma punctatum* Hay (1892, pp. 435-437). Description and a synopsis of life history.
- Smith, B. G. (1910, pp. 204-211, figs. 1-5). Descriptions of spermatophores and spermatozoa, with comparisons of the latter with those of *Triturus viridescens*.
- Smith, B.G. (1911, pp. 14-27, pls. 1-3). Habitat, spring migration, spawning season, adults, eggs and their envelopes, development of eggs and larvae.
- Hurter (1911, pp. 75-77). Records specimens from various counties in Missouri, giving dates of collection, habitat, etc.
- Ambystoma maculatum* Dunn (1918, pp. 456-457). Synopsis of the larvae of *A. opacum*, *tigrinum*, *maculatum* and *jeffersonianum*.
- Brimley (1921, pp. 26-27). Breeding dates; variation in maculation; citation of case of eggs being laid on land.

- Smith, L. (1921, p. 41). A mass of eggs found on land.  
Breder, Ruth B. (1927, pp. 51-56, ill.). Breeding habits.  
Pope, P. H. (1928, pp. 99-100). Captive specimens 18 and 12 to 13 years old.  
Ruthven, Thompson and Gaige (1928, pp. 22-24, text fig. 4, pl. 4, figs. 1-2).

Description, summary of habits and habitat.

- Smallwood (1928, pp. 90-91). Food of adults throughout the year and of larvae.  
Blanchard, Frank N. (1930, pp. 154-167). Concludes that "migration to breeding ponds depends. . . on rain and not on temperature."

Mohr (1930, pp. 50-55). A brief discussion of egg-laying and the stimuli prompting breeding.

Mohr (1931, pp. 102-104, fig. 1). Description of spermatophores of *Ambystoma jeffersonianum*, with comparisons with those of *maculatum*.

*Type locality:* Carolina.

*Diagnosis:* An *Ambystoma* with 11 costal grooves, a single plantar tubercle, a median and a lateral series of vomerine teeth, the latter series extending beyond the nares, and a color pattern consisting of a dorso-lateral series of round, yellow or orange spots on head, body and tail, whose ground color is black to bluish, belly lighter and immaculate. Total length 6-7 inches (150-175 mm.).

*Comparisons:* Of the Kansas *Ambystomas*, *tigrinum mavortium* resembles *maculatum* most closely, but the 12 costal grooves, two plantar tubercles and the spotted or barred belly of the former serve to distinguish them. *A. texanum* and *annulatum* (the latter recorded from Stone county, Missouri, by Noble and Marshall, 1929) differ from *maculatum* by the fact that the vomerine teeth do not extend laterally beyond the nares.

*Description of adults:* (Female, KU 950. Douglas county, Kansas) Head broad, somewhat flattened, skin porous in orbital region; distance between nares nearly equal to interorbital space; distance between nares and eye about equal to longitudinal diameter of latter; nostrils near end of snout, small; lores rounded; angles of jaws extending posterior to orbits about  $\frac{1}{2}$  the longitudinal diameter of the latter; a lateral longitudinal groove from posterior border of eye to gular fold; latter interrupted in temporal region by a transverse fold passing posterior to angle of jaws and extending onto both dorsal and ventral surface of head, but not meeting; gular fold strong, the two lateral ends extending far into the dorso-lateral region; internal nares somewhat more distantly separated than external; vomerine teeth in four, apparently three, patches, the two median series in contact medially, extending laterally almost to medial borders of choanae, and with a slight concavity, sometimes double, on the anterior face; lateral series of vomerine teeth short, extending considerably beyond lateral borders of choanae; tongue broad, flat, with free edges and longitudinal plicae radiating from behind; 0-2 costal grooves separating adpressed limbs; fingers 2-5-3-4 in order of increasing length, toes usually 1-2-5-3-4, with the 2nd and 5th, and 3rd and 4th, nearly equal in length, the latter group the longer; costal grooves 11 (sometimes apparently 12); a single plantar tubercle (sometimes none); a very faint median dorsal groove; tail elliptical at base, much compressed distally; a lateral groove on each side of tail, somewhat nearer dorsal than ventral margin.

Color black to bluish above, with medium-sized, rounded, yellow or orange spots on head, body and tail and limbs; ventral surfaces lighter than dorsal, immaculate, rarely with small dark spots in the gular region.

*Sexual dimorphism:* Sexually dimorphic characters are few in *Ambystoma*. The cloaca of males is finely but deeply plicated to near the exterior, at least during the breeding season, while in females the plicae are absent. Breder (1927), observing specimens in life, states, "The bodies of the females were . . . of a light gray color below while males, on the other hand, were sligher in build and of a more brilliant hue and showed more clearly the typical darker under surface found at other times of year."

*Variation:* Considerable variation may occur in the number of dorsal spots. Brimley (1921) states that they may vary from 52 to none at all. The usual arrangement is in two series, one on each side, extending from the tip of the snout to tip of the tail, with an average of perhaps 15-20 spots on each side.

TABLE I.

Measurements of adult			
Width of head	18.8	Hand	9.7
Head and body	93.5	Hind leg	25.5
Tail	97.0	Foot	11.9
Snout to gular fold	21.0	Orbit	3.3
Axilla to groin	49.5	Interorbital space	6.5
Fore leg	23.6	Internarial space	5.1

Specimen from Douglas county (KU 950).

*Description of larvae:* Dunn (1918, p. 457) summarizes the diagnostic characters of the larvae as follows: "Legs overlap, slimmer, belly not pigmented, more definite demarcation between back and belly, tail not blotched, head smaller, no stripes." Balancers are present and well-developed at the time of hatching (B. G. Smith, 1911), and disappear within about 15-18 days. Smith (*op. cit.*) adds further that there is no arrangement of chromatophores to form spots, as there is in *A. jeffersonianum*. The fore limbs are well-developed and with two digits at hatching, while the hind limbs do not appear until about the 15th to the 17th day. Their heads are narrow and the bodies long and slender, differing in this respect from the larvae of *Ambystoma tigrinum*. Bishop (MS) states that the larvae are about 13 mm. at hatching and "may transform when 42 mm. long, between June 15th and October."

*Breeding habits:* The stimulus which provokes emergence from hibernation and migration to breeding quarters has been proved (Blanchard, 1930) to be dependent primarily upon rain, and secondarily upon temperature. The average temperature may be rather high (50° F.) without a migration, but a rain accompanying an average temperature considerably lower than this (40° F.) would be likely to stimulate a conspicuous migration. Such conditions are met in Kansas in the latter part of March. Males are usually reported as preceding the females to the breeding places, but no sexual activity occurs until the females arrive a day or two later. Mohr (1930) has indicated that this may not always be the case.

The courtship procedure is far more simple than in the Salamandroidea, for instance. In fact, it is much more similar to the primitive type displayed by the Hynobiidae of Asia, to which, of the living salamanders, the Ambystomas are most closely related. Breder's description (1927) of the courtship of *maculatum* are graphic:

Arriving at the Milburn railroad station, Mr. Breder and myself alighted and trekked along the familiar bridle path that led to our destination. A chilling drizzle of rain had started which the beam of our flashlight penetrated with difficulty as we slipped and splashed along through the early spring mud. Surely, I thought this was an unprepossessing evening even for a salamander. As is his wont, nodding non-committally to such observations my side partner trudged along, silently smoking. As we approached the pools which every previous spring had contained eggs, he stopped to get the camera and other paraphernalia in readiness for use, should we need it, and for this reason I preceded him to the pool's edge where after one or two failures, I finally induced my flashlight to stay on. The beam lit up a patch of the woodland pool, the surface of which the rain pellets were dimpling and there as though behind a hazy and rippling curtain lay the reward of persistence. Such a sight—not a few scattered pairs as I had been led to expect but huge squirming masses of handsome brutes entirely engrossed in their courtship.

Together we counted in this one pool five distinct aggregations, each of at least forty to fifty individuals.

Casting the light about the ground at our feet other hordes were seen descending to the pools, so close and in such haste that we had to exercise considerable care to avoid treading on them. On this memorable evening literally thousands of individuals were seen. By eleven o'clock the last of them had arrived and their good sense of direction invariably led them to swim directly to the nearest aggregation and from there on to the more distant units. By this time the peak of activity had been reached and only a few stragglers were out of the water. Here and there on the bottom groups of neglected spermatophores were beginning to become prominent. We, of course, ordinarily associate noise with the breeding activities of frogs and silence with that of salamanders, but in this case the activities were accompanied by a weak but distinct sound. The constant rising to the surface for air and the consequent breaking of small bubbles as they gulped it produced a continuous hum which though audible only a short distance was clearly heard above the patter of the light rain.

A few instances of embrace after the manner of *Triturus viridescens* have been reported, but it is probable that this is not the usual procedure. Wright and Allen (1909) describe the activities of the male, observed in captivity with a female:

The male, at first, showed no signs of excitement, but upon coming in contact with the female, he became very restless, and "nosed" her about in a definite manner. It seemed to be the object of the male to bring the top of his head in contact with the venter of the female. The throat region of the female seemed to be preferred, although he often began in the cloacal region or even at the tip of the tail and rubbed the dorso-lateral part of the head along her whole ventral side. After each performance of this kind, the male swam away and grasped one of the sticks with its hind legs, bringing the cloaca close to the stem. The tail quivered for a moment and, with an arching of the region just caudad of the cloaca, the vent was lifted from the spermatophore. Then, he immediately returned to the female and began again the "nosing" process. The time consumed in depositing a spermatophore varied from 3 to 16 seconds, the periods for thirteen consecutive deposition being: 5, 3, 6, 10, 13, 12, 7, 11, 12, 16, 11, 10, 10 seconds, respectively. In this way twenty-two spermatophores were deposited in 45 seconds.

Most of this time the female remained quiet. Three times, however, she slowly moved over a spermatophore until the vent rested upon it. Then the hind limbs

closed about it. In this position the female remained, each time, for ten to fifteen seconds and apparently made no effort to take any portion of the spermatophore into the cloaca as does *Diemyctylus*. It seemed to us rather that there was a simple passage of the spermatozoa from the spermatophore into the cloaca of the female.

There is not the economy of spermatophore production in *maculatum* that there is in *Triturus*. In the latter the male induces the female to follow him as the spermatophores are deposited, and relatively few of the latter are necessary to accomplish their purpose. On the other hand, *maculatum* deposits spermatophores in such quantities that at times observers have stated it would be almost impossible for females to move about without brushing against some of them.

Not only are the courtship and promiscuous production of spermatophores primitive, but the structure of the spermatophores themselves is equally archaic. Normally one "consists of an expanded hummocky base and a stout stalk, of very clear, transparent, gelatinous material, surmounted by a dome-shaped mass of snowy-white seminal fluid." (Smith, B. G., 1910). The same author finds that the average dimensions of 12 normal spermatophores were: total height, 6.2 mm.; longest diameter of sperm mass, 3.7 mm.; smallest diameter of stalk, 2.5 mm.; breadth, 6.4 mm. Mohr (1931) states that "In *A. maculatum* . . . the white seminal fluid, in addition to coloring the sperm capsule, covers most of the gelatinous stalk, while in *A. jeffersonianum* . . . only the capsule is white."

Compound spermatophores are occasionally deposited. They may be of a Y-shaped, or of a "vertical-serial" type, in which several spermatophores are placed directly on top of each other and more or less telescoped together. (Smith, *op. cit.*)

During the period of courtship there is little wandering, and as a result the spermatophores deposited by a single male are usually grouped together, the number in each group varying from 30-50. They are usually deposited in water about 6 to 10 inches deep, rarely deeper.

From 24 hours to 6 or 7 days elapse between the first appearance of the spermatophores and of the eggs. The latter are usually laid at night under water in bunches attached to various water plants, leaves, twigs, etc. Brimley (1921) and Louise Smith (1921) have reported eggs, probably those of *maculatum*, laid on land a short distance from water. In both cases each egg was distinct, and the capsules were swollen and irregular. Whether or not these would have hatched is problematical; it is still more doubtful, having hatched, that they would have been fortunate enough to have been washed into the water before they died for the lack of it.

Usually the egg masses are formed of clear, nearly transparent gelatin, but occasionally they are cloudy or even opaque. Only a single type is laid by a single female, according to Mohr (1931). The number of eggs in a mass may vary from 1 to perhaps 200, but the usual average is 30-50. The egg complement of a single female varies from 130 to 225. A single bunch, when laid, may be no more than half an inch in diameter, but it soon swells to a diameter of two or three inches. They are then usually oval in shape, and the

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entire mass is very firm and compact, although "the outlines of the individual envelopes are obliterated in the general contour." (Smith, B. G., 1911).

The size of the bunches of eggs, and the time necessary to lay each, varies inversely as the amount of disturbance experienced during the process of egg-laying. If undisturbed, large masses may be laid; if frequently disturbed, as by other animals swimming about, the masses are smaller. Rarely are single eggs laid.

The process of egg-laying has been variously described. According to Clarke (1878), "While the eggs are being extruded the animal usually lies with its anterior limbs extended laterally, while the hind limbs are curved around the opening of the cloaca and appear to assist in holding together the eggs as they are laid." (After Wright, 1908). Wright and Allen (1909) describe the process as follows:

At least thirty minutes are usually consumed in depositing a normal bunch of eggs. One female in depositing a bunch of 140 eggs remained beneath the surface for over an hour. During this time she neither strove to get into a position where she could keep her nostrils out of the water, nor did she once arise to the surface for air. As in other cases, the eggs came out slowly without apparent effort or straining, sometimes but four in a minute. During deposition she was motionless, except for occasional slow movements of the tail. Immediately after deposition, however, for two or three minutes, she swayed back and forth vigorously to disengage herself, for the fresh jelly stuck to the under side of her tail and cloaca. Ten hours later another bunch of 32 eggs finished the complement.

Sixteen to twenty-six days are required for hatching.

*Habits and habitat:* Except during the breeding season the adults are terrestrial, nocturnal and certainly not gregarious, and at such times wander far from the water into open pastures or woods, seeking protection during the day under logs, stones, piles of leaves, etc.

Apparently practically all, if not all, foodtaking is suspended during the breeding season. Only upon leaving the water do the adults once more feed readily, and such creatures as earthworms, centipedes, spiders, insects and other terrestrial invertebrates form the greatest part of their diet. The larvae are also carnivorous and may feed upon fish, and large aquatic insects as well as the smaller invertebrates. (Smallwood, 1928)

In spite of small size, they may be remarkably long lived. Pope (1928) records the ages of 18, 12 and 13 years for three salamanders kept in captivity under his observation.

*Distribution:* Stejneger and Barbour (1923) state the range as follows: "Nova Scotia west to Wisconsin, southward to Georgia and Texas."

KANSAS: DOUGLAS COUNTY: (KU 950).

*Remarks:* Although no specimens of this species have been collected in recent years in this state, Hurter's records (1911) for Missouri in counties adjacent to or near the Kansas border (Jackson, Johnson and Stone) strongly indicate that, whether or not the data on the Kansas specimen are correct, the species must occur in the extreme eastern part of this state.

Cragin's report of 1881 was based upon Jordan's Manual of Vertebrates, and neither author, it is likely, had actually seen specimens from Kansas.



Map 1. Distribution of *Ambystoma maculatum* (Shaw).

***Ambystoma texanum* (Matthes)**

NARROW-MOUTHED OR TEXAS SALAMANDER

*Salamandra texana* Matthes (1855, p. 266).

*Ambystoma texanum* Cope (1867, pp. 204-205). A complete description of adults.

*Ambystoma microstomum* Cope (1867, pp. 206-207). A complete description of adults.

Cragin (1881, p. 119). Recorded from "Kansas" after Jordan (Manual of Vertebrates). No definite locality records.

Morse (1904, p. 110). A short description, with a few notes on habitat.

*Ambystoma microstoma* Cragin (1885a, p. 103). First report of actual specimens from Kansas: Neosho Falls, Woodson county.

Cragin (1885b, pp. 138-139). Same as above.

*Chondrotus microstomus* Cope (1889, pp. 101-103, text fig. 19, pl. 25, figs. 1-2).

*Chondrotus texanus* Cope (1889, pp. 104-105, text fig. 20, pl. 51, fig. 19).

*Ambystoma microstomum* Hay (1892, pp. 427-430, pl. 1, fig. 1). A description of adults, with a few notes on larvae, and apparently the only discussion of life history ever published.

Strecker (1908, p. 80).

Hurter (1911, pp. 72-83). Description, habits.

Gaige (1914, p. 4). "Frequently plowed out of mouse and crayfish burrows."

Strecker (1922, pp. 6-7). Distinguishes *texanum* and *microstomum*. Notes on breeding habits.

Blanchard (1925, pp. 367-368). Notes on larvae and adults.

Strecker (1927b, p. 8). Food.

Cahn (1930, pp. 18-19). Albino eggs.

*Ambystoma texanum* Strecker (1908, p. 80). Discusses characters differentiating *microstomum* and *texanum*.

Strecker (1909a, pp. 17-20). Differentiates *A. microstomum* and *texanum* in detail; short account of time of breeding, eggs and larvae.

Strecker (1922, p. 7).

Gloyd (1928, p. 116). Recorded from Franklin county. Notes on habits and habitat.

Strecker and Williams (1928, pp. 6-7). Synonymizes *microstomum* with *texanum*. Notes on habits.

Gloyd (1932, p. 395). Recorded from Miami county. Notes on habitat.

*Type locality:* "Das erste Exemplar fand ich . . . im Urwalde am Rio Colorado, das zweite ebenfalls . . . im Cumming's Creek [sic] Bottom, Fayette County." (Stejneger and Barbour, 1923).

*Diagnosis:* A non-neotenic *Ambystoma* with two small series of vomerine teeth, separated medially and not extending laterally to medial margins of internal nares; 14 costal grooves; tail slightly shorter than head and body; ground color blackish, with very indistinct grayish spots scattered over back and abdomen, much less numerous on latter, and more concentrated on sides and on mid-dorsal region.

*Comparisons:* *A. texanum* is distinguished from all other species of the genus except *annulatum* Cope by the character of the vomerine teeth and costal grooves; the banded color pattern of the latter species is distinctive.

*Description of adults:* Head short, rounded in dorso-ventral profile; minute pores scattered over skin of head and body, larger ones in region of parotid glands and the supraorbital region; nostrils separated by about the diameter of the orbit, very near tip of snout; distance between nares and orbits about equal to diameter of latter; eyelids terminating posteriorly in a small pocket; a gular fold present, extending to mid-dorsal line; a lateral groove from eye to lateral extension of gular fold, interrupted back of angles of jaws by a transverse fold extending from temporal region to throat, not meeting in mid-ventral line; angles of jaws extending posteriorly beyond eyes, about halfway between latter and postocular transverse fold; lower jaw extending slightly forward of upper; vomerine teeth in two median series, usually in contact, occasionally separated, extending to or not quite to choanae, but never beyond; about 11-12 teeth in each patch, usually disposed in a straight series, but occasionally in a partly double; maxillary teeth in 2-3 rows, extending posteriorly to below middle of eye; tongue oval, attached on all sides, more closely in front; a median lingual groove present, with plicae radiating outward; adpressed fore limb reaching to posterior margin, or middle of, orbit; fingers 2-5-3-4 in order of increasing length, not webbed; 14 costal grooves (occasionally 13); adpressed limbs separated by from 3-6 costal grooves; 2 plantar tubercles present; toes 1-5-2-3-4 in order of increasing length, not webbed; tail laterally compressed, especially toward tip; a median dorsal groove from occiput to base of tail.

Ground color, in life, dark brown to black, the dorsal surfaces with a variable number of grayish spots of indefinite outline, sometimes so numerous as to almost completely cover the dorsal surfaces, at other times rather sparsely distributed; ventral surface with much lighter spots of somewhat more definite outline, about the size of the eye, and usually sparsely distributed, but more numerous laterally; occasionally ventral surfaces uniformly spotted.

*Sexual dimorphism:* There is but little sexual dimorphism. In the breeding season females are larger in girth of body, and the cloacal region of males is swollen. The parotid gland region in male is somewhat enlarged also, and the head is thus somewhat wider.

TABLE 2.  
Measurements of Adults

	1	2	3	4	5	6	7	8
Head and body	28.5	57.0	63.5	76.5	79.5	79.7	85.5	96.0
Tail	13.0	46.0	41.5	58.2	57.8	57.3	58.5	67.0
Greatest width of head	4.9	6.8	9.8	9.0	12.0	10.0	11.0	10.0
Snout to gular fold	6.3	11.2	12.0	13.8	13.0	13.8	14.0	14.0
Fore leg	9.0	13.0	12.8	14.5	15.3	14.2	16.0	14.1
Hind leg	8.1	16.0	15.5	19.5	20.0	18.5	21.9	19.0
Axilla to groin	14.8	39.3	40.0	44.0	45.0	40.0	48.0	52.0

No. 1 is from Neosho Falls, Woodson county (KU 2644); nos. 2 and 4, Cherokee county (KU 4030-4031); no. 3, Doniphan Lake, Doniphan county (KU 6383); nos. 5 and 7, East of Haskell, Douglas county (KU 953-952); no. 6, Olathe, Johnson county (KU 3453); no. 8, Hyatt, Anderson county (KU 15835).

*Description of larvae:* Specimens about three days after hatching; balancers present, well-developed; gills tri-branchiate, a few basal rami; anterior limb buds apparent, but not sufficiently developed to show digits; no posterior limb buds; dorsal fin present, extending to between anterior limb buds; ventral fin present, but only on tail, extending to cloacal region. Ground color greenish-white dorsally, whitish ventrally; a broad black stripe down each side, with about six dorsal cross-bars on body, rather well-defined; about four similar cross-bars on tail, but less distinct than those on body; top of head and bases of gills with scattered pigment. Total length, about 8.76 mm.; width of head, about 1.445 mm.; head length, about 1.8407 mm.; gills, about 1.3514 mm.

Larvae 40 mm. long or longer may or may not, as preserved specimens, show the characteristic dorsal banding. Pigment is absent from the region of the lateral line system, but above these lines the pigment may be uniformly distributed or disposed in cross-bands (probably a matter of age). Below the lateral light line pigment extends to a line between axilla and groin, and is absent on the ventral surfaces of head and body. Pigment is scattered promiscuously over ventral and dorsal fins. All digits are well-developed, not webbed. A horny beak is present on the lower jaw. Bishop (MS, 1926) states that they "transform at about 50 mm. last of May or early June."

TABLE 3  
Measurements of Larvæ

	22.5	21.0	20.0	20.5	20.0	16.8
Tail	22.5	21.0	20.0	20.5	20.0	16.8
Head and body	28.5	26.5	26.0	28.5	28.3	25.2
Width of head	6.8	7.1	6.8	7.0	7.0	6.2
Length of gills	6.5	6.5	4.2	6.0	5.5	4.5
Fore limb	7.9	7.0	7.2	8.1	8.0	7.0
Hind limb	7.8	6.4	7.2	8.1	8.0	7.0
Cleft to snout	8.0	7.5	7.3	8.0	7.5	6.9

All specimens from Haskell Bottoms, Douglas county (EHT).

*Description of eggs:* These are usually laid singly, occasionally 3-4 in a series, on stems of grasses, both coarse and fine, in standing pools. Most are on upright stems, and are 3-4 inches from the surface of the water, but they may be deposited on dead stems, leaves, etc., on the bottom, and be

from 1 to 6 inches from the surface. In captivity they are laid both singly and in strings, frequently with as many as 20 in the latter. This differs somewhat from the report by Hay (1892), who states that "The eggs may be deposited singly, but more commonly they occur in masses of from two to a dozen, and even more." Strecker (1909a) also gives a different account, as "The eggs were in seven clusters containing 8, 7, 6, 6, 5, 4, and 4 eggs, respectively."

The diameter of the eggs (outer membrane) is about 4 mm.; the first inner membrane is about 2.6 mm., the second inner (vitelline membrane) about 2.2 mm., and the vitellus is slightly smaller. The latter is pigmented, with the darker pole light brown, the opposite pole white to cream-colored. Cahn (1930) has reported albino eggs from this species.

*Spermatophores:* Not known.

*Breeding habits:* Very little is known of the breeding habits. Hay (1892) has studied this species with respect to life history more than any other. He states "As soon as the ice is melted they begin to lay their eggs, and it is no unusual thing to have the ponds frozen solidly again after some eggs have been deposited. Some specimens in captivity laid their eggs in the middle of January. Oviposition more commonly occurs during the month of March. It may continue for a space of at least three weeks." In the vicinity of Lawrence eggs have been observed in local ponds as early as April 1, and as late as April 26. However, Gloyd (1928) states "Eggs and newly hatched larvae were collected March 1," so the time of oviposition varies greatly.

The full complement of a single female is probably about 700. One in captivity laid 694 during a single night, and none later (1932).

*Development:* When hatching, the larvae are about 7.5 to 8.0 mm. long, and possess balancers, which disappear in about 9-10 days. The anterior limb buds are evident upon hatching, and in 9-10 days two digits have formed. The posterior limb buds do not appear until later.

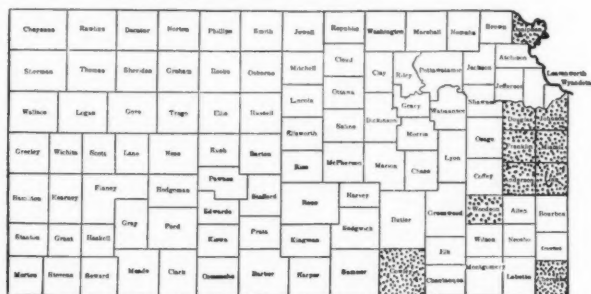
Transformation occurs in the summer of the first year, about two months after hatching, when a total length (according to Hay, 1892) of about 5.50 mm. is reached.

*Habits and habitat:* Hay (*op. cit.*) states that this salamander "spends the winter months in and about the borders of stagnant ponds." It is probable that crayfish burrows are used for hibernation. As soon as emergence takes place in the spring, prompted by warm weather and rains, the salamanders immediately breed. Females remain in the vicinity of the water for several weeks to lay eggs, while males may leave for terrestrial haunts (presuming that fertilization takes place in spring, as in *A. maculatum* and *jeffersonianum*, *et al.*). The completion of oviposition marks the end of the aquatic life of the salamanders for the remainder of the year, as they then take to land, and are discovered only under logs, stones etc., in moist places, sometimes at considerable distances from permanent or semi-permanent pools. Hay (*op. cit.*) states "At this period they do not seem to be able to remain any great length of time in the water, and when left there they have some-

times drowned." Burt (in notes) records a specimen "found under a flat rock in an exposed prairie ledge above a small stream . . . Here the creature was in a surprisingly dry place for a salamander, for there was very little moisture under the stone and such species as the collared lizard (*Crotaphytus collaris*) and the sand snake (*Tantilla gracilis gracilis*) were removed from under adjacent rocks." They occasionally are plowed out of burrows of other animals (Gaige, 1914), and Strecker and Williams (1928) state "Texan salamanders frequently occupy deserted crayfish holes. Occasionally they enter occupied chimneys of these crustaceans, and the latter use their claws for the purpose of clipping portions of the amphibians' tails and limbs. As a result of this practice of intrusion, we found many crippled and mutilated salamanders."

The food of the larvae is entirely animal in nature. Entomostraca are fed upon by smaller specimens, while larger larvae may add small molluscs and insects (Hay, 1892). The food of adults consists, apparently, largely of earthworms. Captive specimens feed readily upon them. According to Strecker (1927) they may also feed upon "sowbugs and insect larvae."

**Distribution:** "South Carolina to Texas, northward to Ohio, Illinois, and possibly Canada." (Stejneger and Barbour, 1923).



Map 2. Distribution of *Ambystoma texanum* (Matthes).

**KANSAS:** Probably ranges over the entire eastern fourth of the state. Actual records are:

**ANDERSON COUNTY:** Hyatt (KU 5835). **CHEROKEE COUNTY:** (KU 4030-4031). **COWLEY COUNTY:** Dexter, 9 miles SE of (CEB). **DOUGLAS COUNTY:** (KU 4234, 4555); Haskell Bottoms (KU 16293; EHT, 17 larvae); East of Haskell (KU 952-953). **DONIPHAN COUNTY:** Doniphan Lake (KU 6388). **FRANKLIN COUNTY:** (Gloyd, 1928; UMMZ 66886, 66887, 68388; OU 301-303, 735). **JOHNSON COUNTY:** Olathe (KU 3453). **LINN COUNTY:** Boicourt (UMMZ 64442). **MIAMI COUNTY:** Pigeon Lake (Gloyd, 1932). **WOODSON COUNTY:** Neosho Falls (Cragin, 1885a and b; KU 2644).

**History:** Cragin reported this species from Kansas for the first time in 1885 (a and b). Two reports have since been published (Gloyd, 1928 and 1932), making a total of three counties from which *texanum* has been previously reported.

*Ambystoma tigrinum mavortium* (Baird)

## TIGER SALAMANDER

- Ambystoma mavortia* Baird (1849, pp. 292-293).  
*Ambystoma luridum*, var. *fasciatum* Hallowell (1857a, p. 252). No exact localities given.  
*Ambystoma luridum* Hallowell (1857b, pp. 309-310).  
*Siredon* (*lichenoides*?) Hallowell (1857b, pp. 309-310). Recorded from Ft. Riley. First positive record from Kansas.  
*Ambystoma mavortium* Cope (1867, pp. 184-192). Detailed description. Recorded from Ft. Riley.  
*Ambystoma mavortium* Cragin (1881, p. 119). Recorded from Ft. Riley and Douglas county.  
 Yarrow (1883, p. 149). Recorded from Ft. Riley and "Kansas."  
 Snow (1889, pp. 31-32, 1 fig.).  
*Ambystoma tigrinum* Cragin (1881, p. 119). Recorded from Manhattan.  
 Hartman (1906, p. 227).  
 Powers (1907, pp. 197-273, pls. 1-9).  
*Ambystoma obscurum* Cragin (1881, p. 120). In hypothetical list.  
*Ambystoma tigrinum* Cope (*part.*) (1889, pp. 68-86, 453-455, pl. 25, fig. 7). Recorded from Ft. Riley, "Kansas" and "Southern Kansas."  
 Hurter (1911, pp. 73-75). Habits.  
 Smith, B.G. (1911, pp. 14-27). Habitat, spring migration, spawning season, adults, eggs, larvae.  
 Ellis and Henderson (1913, pp. 49-50; 1915, pp. 253-254). Habits.  
 Fowler and Dunn (*part.*) (1918, pp. 8-9, pl. 3). Recorded from Ft. Harker and Ft. Washakee, Kansas.  
 Dunn (*part.*) (1918, pp. 457-458). Specimens recorded from "Kansas," and indicated as being of the barred or *mavortium* form.  
 Strecker (1922, pp. 7-8). Variation in coloration and habits.  
 Burt (1927, pp. 2-3). Coloration, eggs. Recorded from Riley county.  
 Strecker (1927b, p. 8).  
 Slevin (*part.*) (1928, pp. 31-36, pl. 2).  
 Taylor (1929, p. 65). Habitat. Indicates that the Kansas species may be *mavortium*. Recorded from Morton county.  
 Tanner (1931, pp. 168-170, pl. 10). Coloration, habits, food.  
 Burt (1932, pp. 75-76). Recorded from Winfield, Cowley county, Kansas.  
*Type locality*: San Francisco Mountain, New Mexico.

*Diagnosis*: An *Ambystoma* with four series of vomerine teeth (the two median series occasionally apparently a single series), the lateral series extending beyond choanae; 12 costal grooves; two plantar tubercles; color above gray or brown, with lateral bars, bands or elongate spots; belly spotted, sometimes indistinctly. Occasionally neotenic.

*Comparisons*: The tiger salamander is distinguished from other Kansas salamanders by the absence of teeth between the orbits, and the presence of vomerine teeth extending laterally beyond the nares, coupled with the coloration. *A. maculatum* is somewhat similar, but has only a single plantar tubercle, the dorsal spots are uniformly circular (not elongated as in *mavortium*), and the belly is immaculate. The barred pattern distinguishes it from the eastern subspecies.

*Description of adults*: Head flattened, broad; a neck usually distinguishable; eyes small but prominent; nares widely separated, the distance between them somewhat greater than from them to orbits; diameter of entire orbit somewhat less than distance between its anterior border and the nostrils; angles



of jaws extending beyond orbits about  $\frac{3}{4}$  the diameter of the latter; vomerine teeth usually in four series, each of the two median about twice as long as one lateral; former frequently in contact, almost invariably distinctly separated from lateral series, which extend beyond the choanae; tongue large, with plicae radiating from behind; tongue attached all around, not so closely laterally, nearly filling cavity of lower jaw; skin of head and body minutely porous; gular fold present, extending dorsad considerably above axilla; a lateral fold from eye to lateral extensions of gular fold, interrupted by a dorso-ventral groove back of angles of jaws; limbs of about equal length, hind limb stouter; fingers 2-5-3-4 in order of increasing length, toes 1-5-2-3-4, 5th and 2nd about equal; two plantar tubercles on both fore and hind limbs; tips of digits sometimes cornified; tail variable in length, but always laterally compressed, not constricted at base.

Color above, brownish to steel gray, lighter below; large whitish blotches on back and sides, usually extending onto ventral surfaces of head and body; dorsal spots, if any, usually not crossing mid-dorsal line, and more rounded in outline than lateral spots, which are usually transversely elongated, extending onto ventral surfaces; tail blotched, as well as limbs, sometimes banded.

*Variation:* The variation in body form and in the shape of various parts of the body are very great (Powers, 1907). Food habits and environment apparently govern this to a large extent. Variation in color, on the other hand, is not so great. The pattern of recently transformed or transforming individuals is of lateral streaks, which gradually, as the animals grow older, become larger, more well-defined and less numerous. The belly, in larvae, is immaculate; darker pigmentation is a gradual development after transformation. Specimens long preserved become brownish, and the spots become so indistinct that they may seem to be absent.

There is apparently but little sexual dimorphism. Powers (1907) indicates that females are smaller in proportion and in relative weight.

TABLE 4  
Measurements of adults

Head and body	70.0	101.0	102.5	114.0	93.0	111.0
Tail	50.2	81.0	72.0	104.0	81.0	103.0
Width of head	14.3	20.1	20.0	21.7	18.6	21.0
Axilla to groin	33.0	45.0	50.0	51.0	42.0	52.0
Snout to gular fold	13.1	23.2	23.4	23.5	20.8	24.0
Fore leg	23.0	28.8	27.5	32.0	29.0	30.0
Hind leg	23.0	31.0	31.0	37.0	29.2	33.0

Specimens from Manhattan, Riley county (KSC 4-9).

*Description of larvae:* Balancers never developed; color, when young, greenish, with no or but 3-4 very indistinct, broad blotches across back; larger larvae uniform grayish above, lighter below, with no markings; a dorsal fin on body, extending to between axillae; a ventral fin on tail, terminating anteriorly at the posterior margin of the anus; lower jaw with a cornified dentary ridge. Size large—much larger than any other Kansas urodele larva. Costal grooves 12; digits free.

Larvae approaching transformation may show some tendencies toward assuming the adult color pattern.

*Description of eggs:* Usually deposited singly, rarely in short series, on weed stems in shallow water in ponds; size large (about 7.5 mm.), with three membranes, aside from the vitelline membrane; the two inner membranes apparently double; space between outer and first inner variable (about 2 mm.); space between the inner membranes apparently rather constant (about 0.45 mm.); vitellus about 3.0 mm. in diameter; gelatin rather fluid.

*Description of spermatophores:* The spermatophores of the adults are not known. Probably they would be similar to those produced by the neotenic larvae. These have been mentioned by Gasco (1881). The base is, according to him, rather wide, and the gelatinous mass is about a centimeter high. The clusters are visible at the top. He describes one instance in which the male deposited several spermatophores, one on top of the other, until a considerable mass had been formed.

*Development:* Larvae hatch in about 14 days (Ruthven, Thompson and Gaige) to 18 or 20 days (Smith, B. G., 1911). Hoy records (1871) 25 days, but his observations may apply to some species of *Ambystoma* other than *tigrinum*, as he records the presence of "holders", which actually do not appear in the tiger salamander. Further details of development have not been recorded.

*Breeding habits:* The breeding habits of the adults are not so well known as those of the larvae. Gloyd (in notes) has recorded eggs near Manhattan as early as February 27; Burt (1927) records eggs discovered on March 7; they have been found in the later cleavage stages as late as April 8 in Cloud and Clay counties.

Migration, which has been observed and recorded in *Ambystoma maculatum* and *jeffersonianum*, apparently is not so characteristic a part in the life cycle of *tigrinum*. B. G. Smith (1911) concludes that "It seems quite probable that, in the case of *A. tigrinum* at least, migration is an event depending somewhat upon ecological conditions."

The courtship of the larvae has been observed in detail by Gasco (1881). In these the courtship takes place under water and consists of no more than rubbing of bodies, varied with short nips at each other and an occasional trip by the male about the adjacent territory. Much lashing about of bodies and tails accompanies the process. When both individuals are sufficiently aroused by this "play," the male moves off in front of the female, who should follow and place her snout in contact with his cloacal region. The male then deposits a spermatophore. Deposition does not occur unless the female thus responds. Sometimes, after the first is deposited, the male crawls off a short distance, depositing another, providing the female follows and acts as before. In this manner 3-7 spermatophores may be discharged. The female may stop over one of these and pick up the head with her cloacal lips. She may even place the spermatophore within her cloaca by pushing it there with her hind legs. If, however, the female does not follow the male at his first invitation, he returns to continue his "play" until she is sufficiently aroused to do so.

Gasco records 1047 eggs as the full complement of a single female. These were laid in groups of 12 to 20.

B. G. Smith (1911) intimates that fertilization may be autumnal, as testes of males at that time are large and swollen, but not in the spring. He

further states that egg masses were found to contain about 53-75 eggs, which is widely different from the number usually found in this region (single eggs to clumps of 2 or 3).

*Habits and habitat:* Mr. H. K. Gloyd has furnished the following interesting notes on the life history of this species:

Feb. 27, 1928. Lost Lake, southwest of Manhattan, Riley county, Kansas. Secured axolotyl larva with 12 ft. minnow seine. Eggs found attached to sticks and weed masses in edge of lake. Were in groups of two or three or singly; in small separate globules of jelly. Appeared to be in very early cleavage stages. No adults captured.

Mar. 6, 1928. Collected several large larvae in same locality with 12 ft. seine. A few eggs were found.

Mar. 8, 1928. One of the above mentioned larvae laid eggs in aquarium the preceding night. When first discovered at 10:30 a.m., some were in the 1-cell stage, others had divided into four cells. Most of the eggs spoiled but two larvae hatched.

This strongly indicates that in this lake the species reproduces paedogenetically. The country around the lake is dry and sandy and the lake lies in a deep bowl-shaped depression with steep sandy sides. There is no shelter that would seem suitable for terrestrial adults.

April 12, 1928. Took 23 larvae with four dips of 50 ft. seine. Eggs still found. Some were brought up from beneath the surface with the seine. Were close to hatching time.

The larvae are carnivorous, living normally at first upon entomostraca, and later upon various aquatic insects, larvae etc. Frequently males (very rarely females) become cannibalistic, feeding upon other larvae, attaining a large size and developing other unusual features in so doing. Strecker (1927b) records an individual which "ate six young toads (*Bufo valliceps* Wiegmann)." After transformation, "During July it ate at least ten young tailless amphibians—tiny toads and cricket and chorus-frogs." Adults are as voracious as the larvae, and "when hungry will snap at a finger or anything held dangling before their mouths." Toads, frogs, mice, earthworms, tadpoles, fishes and insects have been observed by various writers to serve as food occasionally.

The following account is from Hay (1892):

In Indiana this species appears to pass the winter hiding about the margins of ponds, or, in some cases, away from the water, under logs and such places. I have received specimens taken under the ice, in company with *A. microstomum* [texanum], in January and February. Like the latter species, it mostly leaves the water as soon as oviposition is completed. They may then be found burrowing in the earth, when they can be found at all. However, this species, unlike *A. microstomum*, appears to be capable of remaining indefinitely in the water during the summer months and of enjoying its existence there. On the other hand, I have been told of a specimen that was taken in a dry corn-field on a hot day in August. A large specimen that was kept by me for several weeks seemed, during the warmer months, to prefer remaining covered up in a box of sand that was provided. At intervals it betook itself to water. It was observed that this specimen shed its cuticle about every ten days. Before this exuviation occurred it entered the water and remained there for some time after the skin had been cast. During the colder months it preferred to remain constantly beneath the water, only coming up at intervals of fifteen minutes to take in air. Observations showed that this species [see Snow, 1889], like *A. microstomum* and *A. punctatum* [maculatum], enjoys an aquatic respiration. Water is steadily inhaled by the nostrils for five or six seconds, and then expelled by the mouth.

The normal habitat of these salamanders is, in western Kansas and other plains regions, of necessity somewhat different. Taylor (1929) says that

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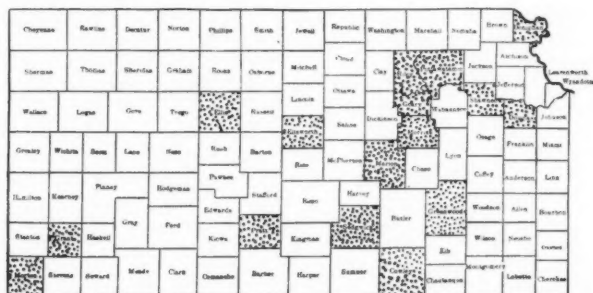
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"Adults were found about midnight coming to the surface of the ground out of prairie dog holes in a prairie dog town about three hundred yards north of the river and about 200 yards from a reservoir. Only a single salamander was found in each hole." Strecker (1922) records them in similar environs: "the adults retire to the deserted habitation of prairie dogs, badgers, and other burrowing mammals but usually make their reappearance on the occasion of the first heavy shower."

The length of life has been recorded by F. C. Blanchard (1932) to be at least 11 years.

The tiger salamander, as many other harmless amphibians, is considered to be poisonous. This belief is, of course, erroneous.

*Distribution:* "In general, the southern half of the Great Plains region." (Dunn, in letter).



Map 3. Distribution of *Ambystoma tigrinum mavortium* (Baird).

KANSAS: Probably state-wide. Actual records are as follows:

COWLEY COUNTY: Winfield, near Southwestern College campus (Burt, 1932; CEB). DONIPHAN COUNTY: Doniphan Lake (KU 4235). DOUGLAS COUNTY: (Cragin, 1881; KU 957-971, 1007-1009, 1012, 1016-1029, 3487, 4234, 4237-4241, 4244-4268, 5195, 15551, 1037, 1042, 1043, 1046, 1047, 1049, 1050, 1053, 1058, 1065, 16455; EHT, 1 spec.; exhibition collection, 1 spec.). ELLIS COUNTY: (L. A. Brennan, MS; HMS, 1 spec.). ELLSWORTH COUNTY: Ft. Harker (Fowler and Dunn, 1918). \*GEARY COUNTY: Ft. Riley (Hallowell, 1857b; Cope, 1868, 1889; Cragin,

\* The Kansas Historical Society has kindly supplied data regarding the location of this fort (in letter). "Ft. Harker, originally Fort Ellsworth, was built in 1864 near present Ellsworth, thirty-six miles from Salina. It was located on the Smoky Hill River at the crossing of the old Santa Fe stage road. In January, 1867, the site of the fort was abandoned and a new one located about a mile east of the old one, in Township 15, Range 8 West."

Fowler & Dunn (1918) mention the tiger salamander from Ft. Washakie, Kansas. In reply to my inquiries, the above Society has indicated that this is probably an error, but that there was a Fort Washakie in Wyoming, from which the specimens were probably taken. The Society says in part: "Fort Washakie, Wyoming: On the Shoshone Indian Reservation, in the Wind River Valley, thirty-two miles a little east of north from Atlantic City. Established June 28, 1869, as Camp Augur. Name changed to Camp Brown, March 28, 1870, and to Fort Washakie, Dec. 30, 1876."

1881; Yarrow, 1883; USNM 4695). GREENWOOD COUNTY: near Toronto (CWH, 1 spec.). GRANT COUNTY: 6 mi. N. of Ulysses (USNM 88788). MARION COUNTY: Cottonwood River (KU 4236); Pond at Florence (KU 972-1005). MORRIS COUNTY: White City (KU 1006). MORTON COUNTY: 81 Ranch, Elkhart (KU 2593-2597); 18 mi. N of Elkhart (KU 4269-4443). POTTAWATOMIE COUNTY: Onaga (KU 1030-1035; USNM 45436, 45440-45442). PRATT COUNTY: Fish Hatchery (KU 1015). RILEY COUNTY: Manhattan (Burt, 1927; Cragin, 1881; KSC 4-11); Lost Lake (Burt, 1927; KSC 391-394). SEDGWICK COUNTY: Wichita (USNM 57060-57061).

**History:** The first indication of the presence of the tiger salamander in Kansas was given by Hallowell in 1857 (a), who gave no exact locality from either Nebraska or Kansas. The first actual report was given by the same author in the same year (1857b). Cope mentions specimens from the same locality (Fort Riley) in 1867. Cragin reported it also from that locality in 1881, and added Riley and Douglas counties. Although mentioned in various later papers (Yarrow, 1883; Cope, 1889; Hartman, 1906; Dunn, 1918), it was not until 1917 that it was reported from a new locality (Fowler and Dunn, 1917. Fort Harker, Ellsworth county). In 1929 Taylor added Morton county, and in 1932 Burt reported it from Cowley county. The species has therefore been reported from only five counties.

***Triturus viridescens louisianensis* (Wolterstorff)**

EASTERN NEWT

*Diemictylus viridescens louisianensis* Wolterstorff (1914, pp. 1-10, 1 pl.).

Wolterstorff (1931, p. 16). Comparisons with other forms of *Triturus*.

*Diemictylus viridescens* Cope (part.) (1889, pp. 207-211, figs. 52-53).

Hurter (1911, pp. 94-96, pl. 18, fig. 8). Description and discussion of habits.

*Triturus viridescens louisianae* Ortenburger (1926, p. 91). Recorded from McCurtain county, Oklahoma.

Strecker and Williams (1928, p. 5). Recorded from Bowie county, Texas.

*Triturus viridescens viridescens* Ortenburger (1929b, p. 26). Recorded from Adair county, four miles north of Stilwell, Oklahoma.

Gloyd (1932, pp. 394-395). First and only record from Kansas.

**Type locality:** New Orleans, Louisiana.

**Diagnosis:** External gills present in larvae, absent in adults; vertebrae opisthocelous; no parasphenoid teeth; frontosquamosal arch present; pterygoids not reaching maxillae; latter well separated from squamosal; digits 4-5; cranial carinae present; fifth finger not more than half the length of the fourth; spots on bodies of aquatic adults all small and black, none large and enclosing vermilion or yellow central areas; lores nearly vertical.

**Comparisons:** The family Salamandridae, to which *Triturus* belongs, is distinguished from the suborder Meantes and Proteida by the absence of gills in adults, while the opisthocelous vertebrae distinguish it from the Cryptobranchioidea and Ambystomidoidea, in both of which the vertebrae are amphicoelous. Of the other two families of the Salamandroidea, the Plethodontidae have parasphenoid teeth, and the vertebrae in the Amphiumidae are amphicoelous.

There are at least six genera in the family: *Pachytriton*, *Tylotriton*, *Chioglossa*, *Salamandra*, *Salamandrina* and *Triturus* (*Euproctus* and *Pleurodeles*

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possibly congeneric with the latter). *Chioglossa* and *Salamandra* have no frontosquamosal arch; the pterygoids are fused with the maxilla in *Pachytriton* and *Tylotriton* (by a cartilaginous element in the former and by a bony element in the latter); *Salamandrina* has but four toes.

The genus *Triturus* is widely spread over Eurasia, and is represented in the western hemisphere by six species and subspecies: *torosus* (Eschscholtz), *meridionalis* (Cope), *kallerti* (Wolterstorff), *viridescens viridescens* (Rafinesque), *v. dorsalis*\* (Harlan) and *v. louisianensis* (Wolterstorff). *T. torosus* is allied with the Asiatic species and has no cranial carinae; the remainder are more closely related to the European group and possess cranial carinae. *Triturus meridionalis* of eastern Texas to northern Mexico is distinguished by the absence of both red and yellow spots on the backs of terrestrial forms and aquatic adults, the pattern consisting of small black dots. The longer outer finger (according to Cope, 1889) is also diagnostic, although Wolterstorff (1931) states that the character is variable and therefore unreliable. The head is broader and flatter than in *viridescens*. *T. kallerti* is distinguished by the presence of yellow, black-bordered spots on the back, by the absence of temporal dark stripes, and by the presence of lateral light lines. *T. viridescens* and its subspecies has a narrower head, not so flat, and the light, black-bordered spots, when present, are red. *T. v. viridescens* has a lateral series of round, vermillion, black-bordered spots on the backs of both terrestrial and aquatic forms; in *dorsalis* the vermillion spots are extended longitudinally to form broken lines, at least in aquatic adults. *T. v. louisianensis* has vermillion spots very much like those of *v. viridescens* in the terrestrial stage, but the adults lack these light spots, and have nothing more than minute black spots scattered promiscuously over the dorsum and venter.

*Description of aquatic adults:* Male. Skin of top and sides of head porous, especially about the snout, slightly rugose in occipital and interorbital region; nares situated near tip of snout, in line with canthi rostrales, distance between them about  $2/3$  length of orbit; lores nearly vertical; head somewhat pointed; distance between nares and orbit somewhat less than length of latter; edges of upper jaw, viewed laterally, sinuous, a flap of skin extending down over lower jaw near angles; latter extending somewhat posterior to orbit; tongue oval to diamond-shaped, attached on all sides; vomero-palatine series of teeth very long, between orbits, inverted V-shaped, apex extending nearly to posterior edges of choanae, the two series very closely approximated; temporal region somewhat swollen, pits of hedonic glands present (see Hilton, 1902); two longitudinal carinae extending from occipital region to about halfway between nares and orbits, where they unite and fade away anteriorly; a distinct dorsal rounded ridge on body, terminating anteriorly in occipital region with a Y-shaped ridge, from the arms of which arise the cranial carinae; skin of body and limbs comparatively smooth; fore limbs slender, about 42.34% of head and body length (to posterior border of legs); fingers 2.5-3.4 in order of increasing length, pointed, 2nd a little less than  $1/2$  length

\* Myers (1926, p. 337) states that *symmetrica* (Harlan) has priority over *dorsalis*.



of 5th, latter a little less than  $\frac{1}{2}$  of 4th, 3rd about  $\frac{3}{4}$  to  $\frac{4}{5}$  length of 4th; distinct outer and inner metacarpal tubercles; hind limbs slightly shorter than or as long as fore limbs, and about 3-4 times as large; a series of horny excrescences on posterior ventral surface of femora; excrescences on metatarsal surfaces and on tips of toes; latter 5-1-2-4-3 in order of increasing length; 5th about  $\frac{2}{3}$  length of 1st, latter about  $\frac{1}{4}$  length of 2nd, and this about  $\frac{1}{5}$  shorter than 4th, which is about  $\frac{1}{5}$  shorter than 5th; tail tapering, a dorsal and ventral fin, latter extending to cloaca, former to sacral region; cloaca enlarged, glandular; tail about  $\frac{1}{2}$  longer than body.

Ventral surfaces uniformly whitish, with occasional black spots; dorsal surfaces light olive, black spots more numerous, but small and irregularly arranged; spots on body of tail larger and indistinct, blackish; spots on the dorsal and ventral fin larger than on body but smaller than on body of tail, vertically oval or elongate; limbs similar to body in coloration; spots less numerous on head.

Female: Snout less pointed (lateral view) and head somewhat broader than in males; dorsal ridge broader, hind limbs more slender (about 2-3 times as large as fore limbs) and with no horny excrescences; cloaca smaller; caudal fins not so prominent. Coloration same as in males except a dark stripe on sides from nares through eye to above axilla and thence along sides of body and tail, bordered above and below on tail by a distinct light line; ventral black spots more numerous.

The greatest variation in the above descriptions will occur in connection with the sexually dimorphic characters, such as the horny excrescences, size of hind limbs, caudal fin, cloaca, etc. Great variation may occur in the amount of spotting, but only in the eastern part of the range of *meridionalis* do the dorso-lateral spots begin to enlarge and to develop vermilion areas within them.

TABLE 5  
Measurements of aquatic adults\*

Sex	1 male	2 male	3 fem.	Sex	1 male	2 male	3 fem.
Head width	8.0	7.3	7.9	Hind limb	15.5	15.0	15.0
Head length	5.9	6.0	6.2	Axilla to groin	21.5	19.0	24.0
Head and body	41.8	36.6	40.0	Axilla to snout	17.0	15.0	14.0
Fore limb	18.0	15.5	14.3	Tail	60.0	53.0	47.2

No. 1 is from Pigeon Lake, Miami county (UMMZ 68384); nos. 2-3 are from Imboden, Lawrence county, Arkansas (KU 14267-14268).

*Description of larvae:* Head broader and flatter than in adults, cranial carinae indistinct; distance between nares about equal to or a little more than interorbital space; angle of jaws, to approximately middle, bound together by skin; three pairs of gills, with ventral rami; an opercular (gular) fold; about 13-14 costal grooves; hind limbs about twice as stout as fore limbs, somewhat longer; dorsal fin extending to base of gills (very weak and adhering to body in preserved specimens); a ventral caudal fin; tail usually shorter than body;

\* The head and body length is here taken to the posterior margins of the hind limbs, as the anal region is too variable.



sexual characters not developed; otherwise much as adults. Color uniform whitish below, light brown stippled above, the two regions not distinctly demarcated laterally; frequently a light line from above gills along sides of body onto tail, disappearing distally.

Much variation must occur in the structure and coloration of the larvae between the time of hatching and the time of transformation. In general they are as described above, until the third or fourth month after hatching (if their life history is similar to that of *v. viridescens*), when they assume adult coloration, at which time they closely resemble aquatic adults except for the presence of gills (at least obvious rudiments) and a dorsal fin on the body. They soon transform, losing the gills and all fin-folds.

TABLE 6  
Measurements of larvae

Head and body length	33.1	31.5	32.0	29.0	32.3	33.3
Tail length	---	28.3	---	24.5	19.0	28.5
Diameter of orbit	1.7	1.6	1.8	1.6	1.8	1.8
Fore limb	8.5	9.2	9.0	9.1	9.0	9.3
Hind limb	10.1	10.0	9.8	8.2	10.2	9.1
Axilla to groin	18.5	16.7	18.0	15.5	17.5	18.5
Axilla to snout	12.4	12.2	13.0	12.0	12.9	12.7
Gular fold to snout	8.5	7.2	8.0	8.4	8.4	8.7

All specimens from Columbia, Boone county, Missouri (KU 930-935).

**Breeding habits:** The life history of *louisianensis* has not been recorded in detail, as has that of *v. viridescens*. Because of their close relationship, however, it is probable that many points are the same.

In *viridescens* an active and interesting courtship precedes deposition of spermatophores. Jordan (1891, pp. 267-269) gives a vivid account of this procedure:

If at any time during the month of April several pairs of newts are freshly captured from the ponds, and the sexes kept apart over night, the phenomena of copulation may be observed on bringing the animals together in pairs on the following morning. In many cases an interesting courtship precedes the actual clasping of the female. As soon as the male becomes aware of the presence of the female in his neighborhood, he becomes somewhat agitated, and usually begins to move stealthily towards the female with an air of exaggerated caution. It not infrequently happens that the latter, on perceiving his approach, darts away in a state of great excitement, and has to be patiently approached again and again by her unwearied suitor. When the male is finally allowed to come into the immediate neighborhood of the then passive female, he usually enters upon a series of contortions resembling those witnessed at the time of the discharge of the spermatophores. After a few seconds of this suggestive "Vor-spiel" the male vaults quickly upon the back of the female and clasps her tightly around the body with his strong hind legs. When the animals have been for some time in captivity, or a number of individuals of both sexes are together in one aquarium, this deliberate courtship is not observed, and the male clasps the female without any ceremonious preliminary. It often happens that he first catches the female by the hinder part of the body, but if he retains his hold for longer than a few minutes, he invariably moves forward until he has the female securely clasped under her throat, either directly before or directly behind her fore legs. Once in this position no attempt of the female can dislodge him, and he may cling there for hours. On a number of occasions I have seen females appear much the worse for this rough usage, and on one occasion an apparently robust female lay as if dead for several hours after the male had left her, although she eventually revived.

When the male is thus mounted, a period of comparative quiet ensues, lasting from thirty minutes to several hours in individual cases. During this period the animals remain upon the floor of the aquarium in almost exactly the same spot, and the male is not, as incorrectly stated by most observers, "jerking the female unmercifully around during the whole time." On the contrary, both animals are well-nigh motionless, with the exception of the often-described fanning movement of the tail of the male. This half-stroking, half-fanning motion is kept up with more or less rhythmical regularity, first on one side and then on the other, and probably serves to excite both animals, although heretofore it has not been unnaturally regarded by many observers as for the purpose of diffusing the spermatozoa through the water. The female responds by slowly raising her tail until it forms an angle of  $45^\circ$ , or even a right angle, with her body, and occasionally repeats in her turn the slow fanning movement.

From this condition the male passes gradually into a more violent stage, which has been wrongly stated by some to extend over the whole of the foregoing period. This more violent stage usually lasts for only about ten minutes, and during this time the unhappy female is dragged, jerked and pulled over the whole floor of the aquarium, the entire body of the male meanwhile quivering with intense excitement. The cloaca of the male at the same time begins to swell and to show a few whitish papillae projecting from the sides. At the climax of his agitation the male, after a few rapid bendings of his body from side to side, leaves the female, and with his tail slightly raised, his cloaca distended with numerous white protruding papillae, throws his whole body into a series of rapid and strenuous undulations, and waits for the female to follow him. If she does this and presses her head lightly against his tail and cloacal region, the male soon deposits a spermatophore and then creeps on to a distance of a few centimeters, where, if the female still continues to follow him, he soon deposits another. I have often seen one male discharge as many as three spermatophores in this way, but have never seen one individual discharge at one time more than this number.

The spermatophore consists, broadly speaking, of three parts: a thick, irregular gelatinous mass about six millimeters in diameter which adheres to the bottom of the aquarium; a tough elastic spine projecting upwards from this base; and, borne on this spine, an approximately spherical mass of spermatozoa about one and one-half millimeters in diameter, this mass being a sort of concretion of small balls of spermatozoa.

Jordan further describes how the female follows the male, brushing over the ball of spermatozoa, some of which adhere to the cloacal region, entering the spermathecae, probably by some chemotactic function of the cells of the latter (Noble and Weber, 1929).

The hedonic glands of the male, particularly in the temporal region (Hilton, 1902), serve to stimulate the female to follow the male. The stimuli are indicated to be olfactory in nature (Rogoff, 1927).

The mating starts in the fall, continues sporadically through the winter, and is carried on with renewed vigor until spring, at which time eggs are laid (probably, in Kansas, during the last of March or the first of April).

The eggs are spherical and have a diameter of  $1/16$  (1.5 mm.) of an inch; with their gelatinous envelopes, which are elliptical, the total dimensions are about  $1/10$  by  $1/7$  inches (2.5 by 3.5 mm.). The upper pole of the egg is dark brown, the lower pole light green.

The larvae at hatching are less than half an inch long and are provided with short "balancers," gills and the buds of the fore legs. The hind legs develop somewhat later. (Bishop, 1927).

The eggs are laid singly upon the leaves of submerged water plants. Jordan (1893) describes the process as follows:

She then bestrides the chosen spray of water plant and gathers in with her hind legs the surrounding shoots, pressing them close around her cloaca. She then turns on her side or occasionally on her back, and with her forelimbs outstretched and rigid, with

hind limbs and twigs completely hiding her cloaca, usually remains perfectly motionless for about six to eight minutes. At the end of that time she slowly leaves the 'nest' which now holds an egg, well-protected by the tangle of shoots glued together by the gelatinous secretion poured out of the cloaca.

Gage (1891) states that "The eggs hatch in from twenty to thirty-five days depending upon the temperature." Under laboratory conditions, Pope (1924) hatched them in from 12-18 days.

Normally the larvae of *viridescens* transform in three or four months, and then wander out on land for about two and one-half to three and one-half years, at the end of which time they return to the water as sexually mature adults. During their stay on land the skin is rough, and the color is usually reddish (under certain conditions, olive), and there are no caudal fins. Upon return to the water, dorsal and ventral caudal fins are developed, and an olive coloration is assumed. The recent work of Noble (1926 and 1929a) has shown that many variations may occur in this procedure. Under certain conditions and in certain areas the young never go through a terrestrial stage, but remain through life in the water, unless their living quarters are of such a nature (shallow and ephemeral pools) that they must migrate during summer to other ponds, or hibernate during winter on land to avoid freezing. He has further shown that under such conditions sexual maturity may be attained in a single year, and that neoteny sometimes occurs. Also, he concludes that "none of the adults having open gill clefts or prominent gill-rudiments ever passed through a terrestrial stage in their life history." (1929a, p. 9)

Whether or not the latter conclusion is applicable to the western and southern newt is problematical, but if applicable, then it is very probable that *louisianensis* does pass through a terrestrial stage, for the gill-clefts were not open on any of the adults examined (KU 928-929, Butler county, Missouri; KU 3894-3900, Boone county, Missouri; KU 14767-14768, Lawrence county, Arkansas), although this conclusion does not necessarily follow.

*Habits:* Where found in abundance, the adult newts may be taken during all of the warmer months of the year; and it is probable that they are active during the whole year, unless the cold is too intense. They have been seen swimming under ice an inch thick. They delight most in pools which are fed by perennial springs. Their habits are not so nocturnal as those of many of their kindred. They may be seen at all times of day swimming about, climbing on aquatic plants, floating on the surface of the water, and basking in the sunshine. The food of the adults consists of insects, tadpoles, worms and mollusks. In confinement they become quite tame, and will take pieces of beef or insects from a wire, opening the mouth slowly, protruding the tongue, and gently pulling off the morsel. One has been known to swallow a piece of earthworm twice its own length, and to use its hand in holding the prey.

The outer skin is frequently shed. It is pushed back from the head by rubbing against objects; sometimes the hands are employed to effect this purpose. The process of moulting occupies about an hour and a half. Samuel Lookwood . . . has seen it free itself of the cuticle while under water; immediately the little thing turned around and swallowed the whole skin. Prof. Gage has seen the terrestrial form pull the exuvium off the end of the tail and swallow it. It is also interesting that the newt can utter a faint shrill cry. The tail is extremely prehensile, and may be employed to suspend the animal for some time. (Hay, 1892, pp. 455-456).

Regarding food, Bishop (1927, p. 41) remarks: "They are carnivorous and eat almost anything of an animal nature that can be captured and swal-

lowed. The chief food consists of worms, insects and their larvae, tadpoles of frogs and toads, small crustaceans, and mollusks. On one occasion I found them gorging themselves on the eggs of the Mink Frog, *Rana septentrionalis*. In captivity raw meat, liver or earthworms are taken readily." Hamilton (1932) adds: "The food and feeding habits of an aquatic vertebrate, such as the newt, change as quickly as a group of organisms reach their peak, pass and are replaced by another set. During April, in temporary pools, newts may be gorged with *Eubranchus* one week and in the next mosquito larvae may have taken the place of the fairy shrimp." He records them feeding upon the eggs of *Ambystoma maculatum* and of *Rana sylvatica*. Smallwood (1928, pp. 94-95) states that food taken in the fall may be retained in the alimentary tract until the following spring, and that while breeding the newts eat but little.

Pope (1924) has experimented with the senses utilized in the securing of food, and concludes that in aquatic forms in general smell is more important than sight, and that in terrestrial forms sight is of prime importance, while smell is secondary.

Pope (*op. cit.*, p. 347) further states "The manner of securing prey changes at metamorphosis from seizing it with the jaws to capturing it by throwing the tongue well out of the mouth after the manner of toads."

*Habitat*: Terrestrial forms live on land amongst leaves, under logs, in brush piles, etc., sometimes at rather great distances from water. Aquatic adults may be forced onto land sometimes for hibernation, if the ponds or swamps which they frequent are so shallow that they would freeze to the bottom during the winter, and sometimes in migration from one pool to another (Noble, 1929a). Otherwise aquatic forms are confined to either temporary or permanent pools, swamps and other standing bodies of water. In Kansas Gloyd (1932) records them from Pigeon Lake, a swampy area in the flood plain of the Marias des Cygnes river in Miami county. One specimen was a terrestrial juvenile found in a piece of decaying wood among leaves, bark and debris about ten yards from the north shore of the lake, August 31, 1928." No aquatic adults were secured in spite of much effort in the late fall (perhaps after the aquatic forms, all adults at that time of the year, had gone to land for hibernation). "It was not until April 6, 1929, that an aquatic adult was obtained. This was found in the wooded swamp at the west end of the lake and was caught by hand in water a foot deep. . ."

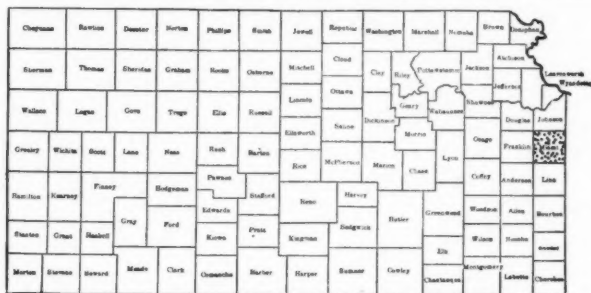
*Distribution*: West to eastern Kansas, Oklahoma and Texas, north to Iowa, including Missouri, southern and western Tennessee, probably to central Virginia, and in the southeastern states except peninsular Florida and the coastal region.

KANSAS: Probably over the entire southeastern and central eastern part of the state. Actual records are as follows:

MIAMI COUNTY: Pigeon Lake, near La Cygne (Gloyd, 1932; UMMZ 68385, 68386).

*Remarks*: Although the actual presence of the newt in this state was until very recently not certain, a number of records from Missouri (Hurter, 1911)

and northeastern Oklahoma (Ortenburger, 1929b) has made it evident that some form of *Triturus* might be expected. All doubt in this connection was removed in 1932 when Gloyd reported it from Miami county. The specimens upon which the records mentioned above were based, however, were considered as *v. viridescens*, which, with the interpretation as given by Wolterstorff (1914, 1931) must be confined to central eastern and northeastern United States. Actual reports of *louisianensis* have been few (Ortenburger, 1926; Wolterstorff, 1914; Strecker and Williams, 1928), although the apparent validity of



Map 4. Distribution of *Triturus viridescens louisianensis* (Wolterstorff).

the form has been reiterated by its author (Wolterstorff, 1931). Distinction of this subspecies from others of the species is apparently purely a matter of color pattern, for a series of measurements of specimens well within the range of *v. viridescens* (by this interpretation) show no constant differences from those of *louisianensis*. A general consideration of the diagnostic characters is given under the paragraph on Comparisons.

***Typhlotriton spelaeus* Stejneger**  
OZARKS BLIND SALAMANDER

*Typhlotriton spelaeus* Stejneger (1892, pp. 115-117).

Dunn (1926, pp. 248-252).

Noble (1927a, pp. 11, 14).

Noble (1927b, pp. 405-419, ill.)

Noble (1930, pp. 61-62, ill.)

Noble and Brady (1930, pp. 52-54).

Smith, H. M. (1932, p. 94).

**Type locality:** Rock House Cave, Missouri.

**Diagnosis:** A normally blind cave-dwelling plethodontid salamander with 16 costal grooves and vomerine teeth continuous with parasphenoid teeth; metamorphosis normally completed.

**Comparisons:** In no other Kansas salamander are the eyelids normally fused together, except in *Necturus*, which is much larger and has but four toes. The number of costal grooves, 16-17, distinguishes the form from all others of this region (*Eurycea lucifuga*, 15; *E. multiplicata*, 20; *E. longicauda* and *melanopleura*, 13-14; *Ambystoma maculatum* and *A. tigrinum*, 11-12;

*A. texanum*, 14), except possibly *Necturus*, which may have as many as 16.

*Description*:\* "M. C. Z. No. 2781, adult male; Marble Cave, Stone Co., Missouri; 16 costal grooves; 4 costal folds between appressed toes; head width 6 in length from tip of snout to vent; head length  $3\frac{1}{2}$  in length of body; head polygonal with angles at the nostrils; eye minute, hidden under the closed eyelids; groove of eyelid shorter than its distance from nostril; snout swollen; a swelling of upper lip below nostril, which forms a short blunt cirrus whose tip is free; outline of upper jaw straight as viewed from side; angle of jaw back of eye; a groove from eye to gular fold; a groove from this down behind angle of jaw; a groove from eye to angle of jaw; limbs well developed; fingers 3,2,4,1, in order of length; toes 4,3,2,5,1, in order of length; tail slightly shorter than head and body, ovoid in section, a thick dorsal keel throughout; anal lips lined with papillae; vomerine teeth continuous with parasphenoids, beginning behind center of nares, passing in and forwards to level of anterior third of nares, forming an acute angle and passing backwards paralleled by its fellow series, separated from it by the width of the nares; no markings; above dark so thickly set with tiny white circular dots that the general effect is grayish white; beneath white; upper surface of limbs and tail and head similar to upper surface of body; total length 115, head 13, body 46, tail 56."

*Sexual dimorphism*: The plethodontid salamanders have, in general, developed sexual dimorphism to an extremely high degree, varying with genera and groups of genera. The dimorphic structures have been studied in detail by Dunn and Noble, who find that they may be the premaxillary teeth, maxillary teeth, the naso-labial and mental glands, and perhaps the bony nodules situated below the eyeball in some species. In *Typhlotriton*, according to Noble (1927a) there is no dimorphism in the premaxillary teeth, which presumably project downward and are typically bicuspid. The palatine nodules mentioned occur in the Plethodontids, according to Noble (*op. cit.*), who discovered their existence, only in certain species of *Desmognathus*. Dimorphism is accordingly restricted to glandular structures—both naso-labial and mental, but more particularly the former.

*Description of larvae*: Eyes small, skin normally continuous over them; three pairs of gills, with numerous rami; fingers and toes not webbed; appressed limbs separated by 4-8 costal folds; costal grooves about 17; a lateral groove extending from gills onto sides of tail; dorsal fin restricted to the tail, terminating above anus; ventral caudal fin extending forward about  $\frac{1}{2}$  to  $\frac{2}{3}$  the length of the tail, continued as a ridge to anus. Brownish above, and on sides, much darker dorsally; ventral surfaces uniform whitish, abruptly meeting the lateral pigmentation in a line extending from axilla to groin; sometimes faint indications of two dorso-lateral blackish stripes extending from behind gills to tip of tail, passing on either side of the dorsal caudal fin; a series of dorso-lateral light spots in young (to about 55 mm. total length) about the neuromasts of the dorsal row, disappearing in specimens about

\* I have been unable to secure adults of *Typhlotriton* in Kansas. Since the collections examined contain no adults from other localities, the following description is transcribed from Dunn (1926, pp. 248-250).



55 mm. in length or longer; dorsal and lateral pigmentation slightly irregular, with lighter areas profusely scattered over entire body, tail and head; limbs brownish above, with large lighter areas, uniform whitish below.

In one specimen (EHT collection) from Cherokee county, there were five digits on one fore limb. Although the eyelids of the larvae are probably normally fused together, Noble (1930) has found that larvae reared in the light "retained and further developed functional eyes. The lids never fused and the retina never dwindled. Further, light-reared individuals were more pigmented than dark-reared ones."

TABLE 7  
Measurements

	A	B	C	D		A	B	C	D
Largest male	128	14	48	66	Largest Larva	93	9	38	46
Largest female	111	13	43	55	Smallest larva	24	3	12	9
Smallest adult	74	9	30	35					

Measurements from Dunn (1926, p. 230). A = total length; B = head; C = body; D = tail.

Of the 74 larvae examined from Kansas, the largest was 84.5 mm. in total length (head and body, 43.5; tail, 41.0); the smallest was 31 mm. in total length (head and body, 20 mm.; tail, 11 mm.).

Eggs: Unknown.

Spermatophores: Unknown.

Breeding habits: Unknown.

**Development:** The larvae collected in Cherokee county were all taken within a few days in the latter part of March and the first of April. The great variation in size of the specimens in these collections indicates very clearly that more than one, and perhaps two, years are necessary for transformation. No size groups, however, were evident in the series.

**Habits and habitat:** The only specimens of this species taken in Kansas were collected about 3.5 miles north of Baxter Springs, Cherokee county, not far from, and on the eastern side of, Spring River. They were all larvae, most of which were taken from two pools fed from the bottom of springs, and isolated in position by about 1000 feet. Pool number 1 was about 14-15 feet in diameter, perhaps about two feet deep, thickly congested with algae and other water plants, and situated in a comparatively clear area in a moderately heavily wooded, hilly region. Considerable numbers of the larvae were collected by removing to the grassy margin of the pool quantities of the loose, fine silt at the bottom, together with the entangled mass of roots and leaves. The larvae could be found by searching through the mud, or by awaiting the appearance of their wriggling bodies as they attempted to escape into the water. After clearing the pool of debris, dip nets were used to secure more specimens, and the remainder were secured after the pool had settled and it was possible to observe the larvae swim about. No specimens were found in the stream fed by the pool.

Pool number 2 was much like the first, except that it was less choked with plant matter, slightly smaller in diameter, deeper, and with steeper margins. Investigations here indicated that most of the larvae were in the deepest and coolest place possible—near the source of the spring. Some individuals were



found in the stream fed by the pool, but within 25 feet of the same, and in small numbers. It was found that, by removing the boards and rocks from the bottom, where the spring entered, and subsequently dipping with a net, considerable numbers of the larvae could be collected. If adults were present in any numbers, they most certainly would have been found in the thorough search which was made of the pools and immediately adjacent areas. It is possible, however, that each of these pools have underground chambers in which the adults live, the larvae remaining for the most part in the surface pools. In regions in which this species has previously been recorded, the adults seem to live entirely in caves, which are near and perhaps connected with the pools and springs in which the larvae live (Hurter, 1911; Noble, 1927b). However, according to various residents of the region in question, there are no caves to be found in the vicinity. This might suggest neoteny, but the several large specimens dissected show no indication of a maturation of the gonads and the accompanying ducts.

Noble (1927), in describing explorations in Marvel (Marble) Cave of Stone county, Missouri, has made some interesting observations of *Typhlotriton*:

We came upon our first *Typhlotriton* shortly after beginning the crawl. It was walking rapidly over the loose stones in an effort to escape. In the light of the lantern its pale tones gave it a most unreal appearance. The beast looked more like some creature fashioned out of dough than a living organism. Its dark eyeballs shone through the translucent lids and gave it a peculiar expression.

Beyond Blendies' Throne, the passageway grows even more difficult as the pools become more frequent and deeper. But here collecting began in earnest. We soon caught one blind salamander under a stone in the water, two together under a stone beside the pool, and another that tried to slide past us in the narrow passage. But most surprising was still another which, when we disturbed it at the edge of a pool, made straight up a sloping bank toward a hole under the roof of the passage. Thus, these creatures with their sightless eyes must have well defined routes of travel and escape. By frequently touching their snout to the ground they are able to make considerable speed between the loose pieces of lime and dripstone which floor their passageways.

A study of a great many springs in Stone and adjacent counties revealed that the larvae were far more abundant in springs outside of caves than within the region of darkness. This is true even though the larvae are negatively heliotropic—individuals kept in a tank retreating under the debris during the day and appearing during the night.

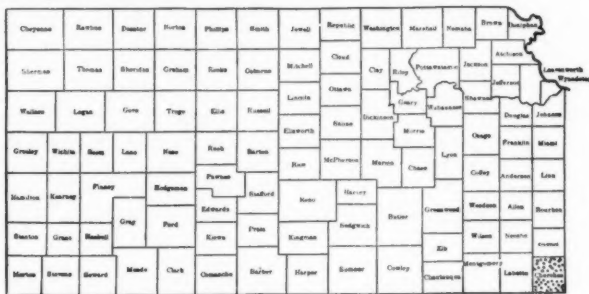
In regions where the springs harbored larvae of several species of salamanders, Noble (1927b) found that those "where the temperature ranged below 65°F. *Typhlotriton* was the dominant larva."

Further, Noble (*op. cit.*) observed that:

Both species [*Eurycea multiplicata* and *Typhlotriton*] during their larval life are highly thigmotactic, that is, are more comfortable when in contact with several surfaces, and spend much of the day between rocks among which water flows rapidly. In the pile of loose stones at the mouth of Woods' Cave, an area of only 22 ft. 6 in. by 5 ft. 10 in. in extent, more than three hundred larvae were captured. We found one adult but no larvae, in the many yards of pool gravel within this cave. If metamorphosis brought with it an urge to climb away from the rushing spring water to the quiet cave pools beyond, these larvae, which even before metamorphosis readily climbed out of my milk cans and other containers, would most surely make their way into the caves, for the only other direction not flanked by scorching blocks of lime-

stone led to the warmer pools where we knew by both observations and experiment were not favorable to the species.

**Distribution:** Ozark plateau in Missouri, Arkansas, southeastern Kansas and probably northeastern Oklahoma.



Map. 5. Distribution of *Typhlotriton spelaus* Stejneger

**KANSAS:** Probably limited to the extreme southeastern corner. Actual record:

**CHEROKEE COUNTY:** 3-5 miles N of Baxter Springs, near White River (Smith, H. M., 1932; KU 16036-16045, 16349-16360, 16153-16160; EHT, 44 specimens).

### *Eurycea melanopleura* (Cope)

*Spelerpes melanopleura* Cope (1894, pp. 383-384).

*Eurycea melanopleura* Dunn (1926, pp. 316-320).

Noble (1927a, p. 7).

Noble (1927b, pp. 415, 418).

Noble (1929b, p. 2).

Ortenburger (1929b, p. 26).

Smith, H. M. (1932, p. 95).

**Type locality:** Riley's Creek, White River, Missouri.

**Diagnosis:** An *Eurycea* with 13-14 costal grooves; pigment on back arranged in two closely approximated rows of dark spots usually completely interrupted on the median dorsal line; tail not barred, extremely long.

**Comparisons:** *Eurycea longicauda*, *E. lucifuga* and *E. multiplicata* are the only other forms of the genus which have been collected in or near Kansas. *E. longicauda* differs in the irregular arrangement of the median dark spots, which are not interrupted in the median dorsal line; the tail is usually distinctly barred. *E. lucifuga* has 15 costal grooves and is reddish in color. *E. multiplicata* has 20 costal grooves and is "grayish, a brownish dorsal band extending over head and dorsal surface of tail, light on sides and belly;" (Dunn, 1926, p. 314). The mushroom-shaped tongue, functional eyes and naso-labial groove distinguish it from other Kansas salamanders.

**Description of adults:** Head not conspicuously flattened; eyes large, the lids terminating posteriorly under a transverse fold of skin; diameter of orbit somewhat greater than distance from orbit to tip or snout; nares much nearer

tip of snout than orbit, visible from above; outline of head from above rounded, somewhat broader, canthus not distinct; tongue large, mushroom-shaped; parasphenoid teeth separated medially, forming two series, more nearly in contact anteriorly, and extending forward to about the middle of the orbit; vomerine teeth in two series, extending from nares medially for a short distance, gradually turning caudad and extending toward parasphenoid series for about  $\frac{1}{4}$  diameter of orbit, nearly meeting posteriorly on the median line; angles of jaw posterior to orbits; gular fold very distinct, passing dorsally on sides to the junction with a groove extending posteriorly from orbit; a groove extending posteriorly from orbit; no postorbital transverse groove; a groove from near angle of jaws to groove of lower eyelid; 13-14 costal grooves; adpressed limbs barely touching, or separated by as many as three costal grooves; digits not webbed; fingers 2.5-3.4 in order of length; toes 1.5-2.4-3 in order of length; mid-dorsal groove distinct; a lateral groove across costal folds sometimes indicated.

A broad, pale cadmium yellow dorsal stripe on body, bordered laterally by a definite blackish area extending to sides of venter and becoming gradually lighter and interspersed with spots of same color as dorsum; ventral surfaces of body white, immaculate; a double series of closely approximated black spots down middle of back, narrowly separated on the mid-dorsal line; top of head of same color as back, with small black spots irregularly placed over it; black band on sides of body extending to posterior margin of eye; mental region finely stippled with blackish; dorsal surfaces of limbs blackish, with numerous broken light areas similar to dorsum of body; ventral surfaces of legs whitish, minutely stippled with blackish laterally; tail much like body, but mid-dorsal spots absent, terminating at sacrum; no lateral bars on tail; ventral surfaces pale cadmium yellow, interspersed with white, immaculate.

*Sexual dimorphism:* Noble (1929b) states "It has not been pointed out previously [in *Eurycea bislineata bislineata* (Green)] that the adult males during this period [from October to May, and possibly longer] have elongate monocuspid teeth in both jaws, the premaxillary teeth being directed slightly forward, while the females have shorter bicuspid teeth in both jaws. Adult *Eurycea melanopleura* show a similar sexual dimorphism of dentition during the fall but not in July. Possibly all species of *Eurycea* will be found to undergo an annual change of dentition in the adult male from bicuspid to mono-cuspid teeth and the reverse . . .". Noble (1927a) further states that sexually dimorphic glandular hypertrophy of both the mental and cirrus types occur in general. Hypertrophy of the mental gland is not so conspicuous in specimens examined as of the cirri.

TABLE 8.  
Measurements of adults

	1	2	3	4	5	6	7	8	9	10
Total length	133.5	75.9	69.0	73.0	76.8	73.3	85.0	76.4	80.2	92.0
Length of tail	88.5	44.4	39.0	42.0	44.5	42.9	52.0	42.6	80.2	92.0
Width of head	8.0	5.5	5.4	6.0	5.8	5.9	6.0	5.8	5.8	7.3
Fore leg	12.0	9.0	8.0	8.2	9.1	9.1	10.1	9.8	9.5	13.0
Hind leg	13.0	9.2	9.0	9.5	9.3	10.1	10.6	10.2	10.0	13.8
Axilla to groin	23.7	17.5	15.2	16.0	18.0	16.9	18.9	18.6	17.5	22.4

No. 1 is from Shoal Creek, near Galena, Cherokee county (KU 6387); the remainder, 4 mi. N. of Baxter Springs, near Spring River (EHT).

*Description of larvae:* According to Dunn (1926), the larvae may be distinguished from those of all other plethodontids except *Eurycea longicauda*, to which it is closely related, as follows: dorsal fin absent on body; costal grooves 13-14; gills with long rami; back lighter than sides; toes 5 in number; a sharp and uninterrupted demarcation between the lighter back and the darker sides, lower row in form of a definite stripe, sides black.

*Development:* Noble (1927b) states that in southern Missouri near Marble (Marble Cave "a few metamorphosing *E. melanopleura* were found in some springs, but as these were of small size [latter part of September], it was clear that they, as do all plethodontids of the Ozarks, save *Typhlotriton* and *E. multiplicata*, metamorphose the first year."

*Eggs:* Not known.

*Spermatophores:* Not known. See spermatophores under *E. multiplicata*.

*Breeding habits:* No direct observations have been made upon the breeding habits of this species. Noble and Brady (1930) have indicated that courtship in plethodontid salamanders is more or less of a certain pattern, which *melanopleura* might be expected to follow.

We have studied the courtship of a series of plethodontid salamanders, in the dark room, using a red light for illumination. A variety of receptacles and temperatures were used in making the observations. Courtship behavior in the following forms was observed during the past year: *Eurycea bislineata bislineata*, *E. b. cirrigera*, *E. guttolineata*, *Manculus quadridigitatus quadridigitatus*, *Desmognathus fuscus auriculatus*, *D. f. fuscus*, *D. phoca*, *D. quadra-maculatus*, *Stereochilus marginatus*, *Plethodon glutinosus*, *P. cinereus*, *Hemidactylium scutatum*, *Hydromantes genei*, *H. italicus*. Because large series were available, observations on *Eurycea b. cirrigera* and *Stereochilus* are the most detailed. The general pattern of courtship is essentially the same in all these species even though some are aquatic and some are terrestrial. In all species, so far as determined, there is a series of preliminary rubbing movements during which the male applies lips, cheeks, mental gland, or side of body to the snout of the female. This arouses the female's interest in the male. In the second phase of the courtship, the female follows the male, keeping her chin pressed closely against his tail base as they move about the tank. The male, especially when he is not moving forward, undulates the base of his tail from side to side. Side to side movements of the head of the female, previously reported for *Eurycea b. bislineata* by Noble, 1929, occurs mainly in the case of small females with comparatively short legs.

At the height of the courtship, after the female has assumed her position behind the male, the latter often turns and pushes the female in the cloacal region with his nose. This causes the pair to move in circles about the aquarium. Another posture and movement not previously reported is the lifting of the body and the arching of the tail of the male while the female is following him. This may tend to raise the fore part of the female from the floor. Another peculiar attitude during the same period is the turning forward of the tail of the female in some species, particularly in *Eurycea b. cirrigera* and *Stereochilus*. Still another distinctive position, noted especially in *Stereochilus* and *Hydromantes*, is the forcing of the mental glands tightly over the nostrils of the female while the male maintains a position directly over her back.

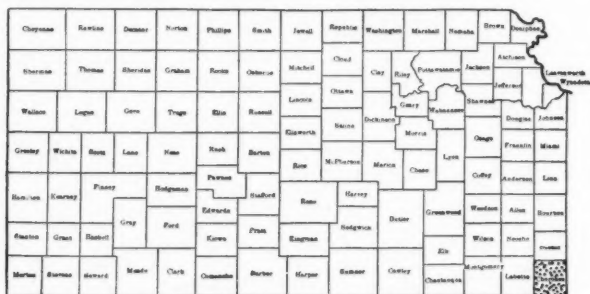
*Habits and habitat:* In 1931 and 1932 specimens of this species were found under rocks at the margins of a spring pool north of Baxter Springs, Cherokee county (see description of pool number 2 under *Typhlotriton*). No lar-

vae were found, as the collecting was done during the last of March and the first of April. Larvae presumably transform during the first year.

Hurter (1911, p. 88) states:

This species is also a twilight species, as it is mostly found under slabs of rock at the mouth of caves and never at a very great distance into the cave. At Wilson's cave—a small cave—I found this salamander among the rocks which dam the little creek at the mouth of the cave. When I visited the cave there was no running water but a little pool just inside the cave. I managed to capture a few small larvae. Near the residence of Hon. Thurman S. Powell, near Marble Cave, I found a good many of these salamanders in holes under rocks at the bottoms and sides of the cave, where they were clinging to the rocks. At Green's cave, Franklin county, which has a large portal-like entrance, I caught some of them under rocks in the water, but not further back in the cave than daylight penetrated. Those from Jerome and from near the Onondago cave were caught under rocks on the shady side of the ravine. Those at Pineville I fished out of a little spring on the side of a hill in an open pasture.

*Distribution:* Southwestern and central Missouri, northwestern and central Arkansas, northeastern Oklahoma and southeastern Kansas.



Map 6. Distribution of *Eurycea melanopleura* (Cope).

KANSAS: Probably limited to the extreme southeastern corner of the state. Actual records are as follows:

CHEROKEE COUNTY: Shoal Creek, near Galena (KU 6387); Spring near Galena (KU 16020); 4 mi. N. of Baxter Springs, near Spring River (Smith, H.M., 1932; EHT, 7 specimens).

#### *Eurycea multiplicata* (Cope)

*Spelerpes multiplicatus* Cope (1870, pp. 106-107).

Cope (1889, pp. 162-163). A specimen mentioned from southern Kansas.

Hurter (1911, pp. 90-91). Records from Missouri.

*Eurycea multiplicata* Dunn (1926, pp. 313-316).

Noble (1927b, pp. 417-418). Notes on habits and development.

Noble (1929b, p. 4).

Ortenburger (1929b, p. 26). Recorded from northeastern Oklahoma in Delaware county.

*Type locality:* Red River, Arkansas.

*Diagnosis:* A *Eurycea* with 20 costal grooves, yellow coloration, weak limbs, rudimentary first toe.

*Comparisons:* The number of costal grooves is sufficient to distinguish this from other Kansas salamanders.

*Description of adult:* [From Dunn (1926, p. 314)]. No specimens have been available for description. "M. C. Z. No. 2983, adult male; Pulaski Co., Ark.; 20 costal grooves; 9 costal folds between appressed toes; head width  $6\frac{1}{2}$  in length from tip of snout to vent; head length  $4\frac{1}{2}$  in length of body; head a pointed oval; eye longer than its distance from tip of snout; snout swollen; a swelling of upper lip below nostril but no developed cirrus; outline of upper jaw straight as viewed from sides; angle of jaw forward of hind angle of eye; hind part of lower eyelid with groove into which upper fits so that but part of lower projects backwards spur fashion; a groove from lower eyelid to angle of jaw; a groove from eye back on sides of neck to gular fold; limbs short; fingers 3,2,4,1 in order of length, toes 3,4,2,5,1 in order of length, first very short; tail longer than body, cylindrical at base, flattened at tip, keeled above throughout; anal lips lined with papillae; vomerine teeth not connected with parasphenoids, 6-7 in a series, curving in and back from level of inner edge of nares, separated from each other by the width of nares and from the parasphenoid by  $\frac{2}{3}$  their own length; parasphenoids in two well separated patches beginning at the posterior fourth of eyesocket; grayish, a brownish band extending over head and dorsal surface of tail, light on sides and belly; total length 68 mm., head 6.5, body 20.5, tail 32."

*Sexual dimorphism:* Hedonic glands "form a small but distinct dorsal protuberance at the base of the tail of the male *Eurycea multiplicata*." (Noble, 1929b, p. 4). As in other *Eurycea*, according to Noble (1927a, p. 14), the mental gland is hypertrophied in males.

*Description of larvae:* [From Dunn (1926, pp. 61-62)]. No dorsal fin; eyes present, pigmented, legs normal, 20 costal grooves; gills with long rami; toes 5; a sharp but broken demarcation between the lighter back and the darker sides, lower row absent.

TABLE 9.  
Measurements

Largest male	---90.0	7.5	39.5	43.0	USNM 57167 Stone Co., Mo.
Largest female	---81.0	6.5	33.0	42.5	USNM 57173 Pulaski Co., Ark.
Smallest adult	---41.0	5.0	25.0	11.0	USNM 36961 Little Rock, Ark.
Largest larva	---47.0	5.0	22.0	20.0	FMNH 538 Fayetteville, Ark.

Measurements from Dunn (1926, p. 315).

*Eggs:* Not known.

*Spermatophores:* Not specifically known. Noble and Weber (1929, p. 15) suggest "that all plethodontids deposit stalked spermatophores and that the females remove the head and part of the stalk with their cloacal lips."

*Breeding habits:* Not specifically observed. See Breeding Habits of *Eurycea melanopleura* for general behavior in plethodontids.

*Development:* Larvae do not transform during the first year. Presumably two years are requisite (Noble, 1927, pp. 417-418).

*Habits and habitat:* This species can apparently exist only in regions of

caves and springs, in the former of which the adults live, while in the latter the larvae develop.

A detailed examination of the springs and caves revealed that the adult *multiplicata* was thoroughly aquatic, reminding one greatly of the eastern *Leuognathus marmorata*. On two occasions the adults were found half a mile in from the entrance of a narrow, winding cave. Such regions are, of course, perpetually dark, but the *multiplicata* had well developed eyes and pigmentation. The larvae, on the other hand, showed a distinct preference for warmer spring waters. In springs where the temperature ranged below 65° F. *Typhlotriton* was the dominant larva. Where it rose above this level *multiplicata* became much more abundant. Springs flowing for a distance under the surface rock and warmed to 70° usually contained only *multiplicata* larvae, although among the great number of records obtained exceptions have been found. In brief, of all the Ozark salamanders obtained, only two have an extended larval life in the water, and these two species usually avoid competition by selecting waters of different temperatures. The species which frequents warm water metamorphoses without losing either its eyesight or pigmentation, but the one that lives in cold water undergoes a remarkable change at metamorphosis, its pigmentation is reduced, and the eyelids which form never open more than a small slit. (Noble, 1927b, p. 418)

**Distribution:** "From Stone Co., Mo., to Little Rock, Ark. The Jemez Mts., N. Mex. Distribution apparently very discontinuous and the animal is common only in the Ozark region." (Dunn, 1926, p. 314)

**KANSAS:** Probably only the extreme southeastern corner of the state. The only actual record is Cope's of 1889, from "southern Kansas," based upon a specimen sent him by Cragin. The specimen has unfortunately since been lost, but the identification by the author of the species of a specimen collected by as reliable an individual as Cragin should be sufficient evidence of the existence of the species in southeastern Kansas. More recent records from northeastern Oklahoma (Ortenburger, 1929b), northwestern Arkansas and southeastern Missouri (Dunn, 1926) definitely support this conclusion.

### *Necturus maculosus maculosus* (Rafinesque)

#### MUDPUPPY OR WATERDOG

*Sirena maculosa* Rafinesque (1818, p. 41).

*Necturus lateralis* Cragin (1880, p. 120). In hypothetical list.

*Necturus maculatus* Cragin (1885a, p. 103). First report from Kansas.

Cragin (1885b, p. 139). Same as above.

Hay (1892, pp. 418-420). Description and discussion of habits.

Cope (1889, pp. 23-27). A complete description.

*Necturus maculosus* Hurter (1911, pp. 64-66). Description, habits, habitat.

Pearse (1921, pp. 1-8, 1 fig.). Habits.

Bishop (1926, pp. 1-60, 11 pls.). The most complete discussion of habits and development which has appeared.

Cahn and Shumway (1926, pp. 106-107). Albino and melanistic larvae.

Ruthven, Thompson and Gaige (1928, pp. 12-15). Descriptions, habits and habitat.

Bishop (1932, pp. 1-3, 3 figs.). First description of spermatophores.

Hamilton (1932, pp. 83-84). Food and feeding habits.

*Necturus maculosus maculosus* Bishop (1927, pp. 30-34, figs. 9-11). A brief and interesting summary of life history and habitat.

**Type locality:** "Found in the Ohio River." (Stejneger and Barbour, 1923).

**Diagnosis:** Normally with external gills (three pairs) throughout life; pectoral and pelvic girdles and associated limbs present; maxillae absent; teeth



of upper jaw in two parallel series, consisting of a short premaxillary series of 11-15 teeth, closely approximated posteriorly by a vomeropalatine series of 12-16 teeth continued posteriorly to angle of jaws by pterygoid series; fingers and toes 4.

**Comparisons:** The Proteida is the only one of the five suborders of the Caudata in which gills are normally retained throughout life and both anterior and posterior limbs are present. Members of the suborders Cryptobranchoidea, Ambystomoidea and Salamandroidea normally lose their gills as adults; members of the suborder Meantes possess gills as adults, but only the anterior limbs are present. There are many other characters which isolate the Proteida, some of which are of greater phylogenetic significance than those pointed out here, but the latter are perhaps the more conspicuous. There are two genera of the Proteida: *Proteus* (central Europe) and *Necturus*, in the former of which the digits are 3-2. *Necturus* is represented by two species: *maculosus* and *punctatus* (Gibbes). The latter is distinguished by the smaller number of teeth in the upper jaw (6-8 on premaxillaries and 8-9 on the vomero-palatines).

**Description of adults:** Head broad, somewhat flattened, snout truncate; a fairly distinct canthus rostralis; external nares widely separated, opening at extreme tip and at angles of snout; eyes small, lidless, somewhat farther apart than nares, directly above or above and slightly anterior to angles of jaw, and about  $\frac{1}{3}$  the distance from the end of the snout to the base of the gills; latter three in number on each side, a very distinct gular fold between; a distinct flap or fold of skin on each side of lower jaw; tongue extending anteriorly to between internal nares, anterior edge free and rounded; internal nares slit-like, opposite the interruption between the vomeropalatine and pterygoid series of teeth; anterior and posterior limbs subequal in size; fingers 5-2-3-4 in order in increasing length, toes 2-5-3-4; anus circular to longitudinal, a large cloacal gland surrounding it and extending anteriorly nearly to between legs; tail strongly compressed laterally; costal grooves 14 (occasionally 15 to 16); a distinct dorsal groove extending from snout to base of tail; frequently a lateral groove extending from above axilla to above groin.

Color blackish to light brown, obscurely speckled with white; dark, ill-defined, somewhat circular and rather numerous blotches dorsally, and laterally on venter; median ventral line lighter and not spotted; a dark line from tip of snout through eye to gills (sometimes indistinct).

TABLE 10.  
Measurements of adults

Head and body	176.0	256.0	123.5
Tail	87.0	88.0	53.5
Snout to gular fold	39.5	34.3	35.5
Greatest head width	34.0	28.5	26.3
Interorbital space	19.0	21.5	11.6
Space between nares	12.0	9.6	10.9
Fore leg	28.9	26.5	19.4
Hind leg	20.0	22.0	19.5
Axilla to groin	82.0	83.0	57.0

No. 1 is from Ossawatimie, Marias des Cygnes River, Miami county (KU 812); no. 2, Marias des Cygnes River, Franklin county (KU 805); No. 3, Lawrence, Douglas county (KU 949).

*Description of larvae:* Immediately after hatching the larvae appear as follows:

A very narrow light line follows the sharp edge of the dorsal ridge. A strongly pigmented median dorsal band originates on the snout a little in front of the eyes and continues along the back and on the tail where it fades out toward the tip. On the head it maintains a width about equal to the distance between the eyes but just behind the gills it narrows abruptly. The dark dorsal band is bordered on each side by a somewhat narrower yellow band which in this stage is free from dark pigment. These light bands originate opposite the base of the third gills and continue along the upper parts of the sides and the basal third of the tail, where they are usually lost in the general pigmentation of the upper tail fin. On the head the dark median area is bordered on either side by a short light bar which originates in front of the gills and passes to the upper margin of the eye. In some individuals it narrows above the eye and continues to the snout.

Below the lateral light bands are the conspicuous dark stripes of the sides, extending from the gills to the tip of the tail. They are continued on the head in bands that curve downward in front of the gills, pass through the eyes and run together on the snout. Below the dark bands the pigment gradually fades out as it spreads over the yolk distended abdomen, the upper surface of the limbs and the gill branches. In some individuals there are a number of small, rounded light spots quite regularly spaced throughout the length of the lateral band. (Bishop, 1926, pp. 21-22).

This coloration is gradually changed to conform in the adults to that given above, the striped pattern being lost at about the end of the third year.

Cahn and Shumway (1926) record both melanistic and albinistic larvae. They apparently occur but rarely.

*Description of eggs:* Three gelatinous layers envelop the vitellus, the inner being comparatively thin but very dense, the middle layer thicker but less dense, and the outer very thick and less dense than either of the other two, and by which the egg is suspended from the base. When in water "the short diameter of the outer envelope is about 11 mm. and the long or vertical diameter (as the egg hangs in natural position) about 14 mm." (Bishop, 1926, p. 17). The eggs are non-pigmented.

The usual manner of deposition is in "nests" situated in water 3-5 feet deep and about 50-100 feet from the shore. The eggs are deposited singly, but in groups of 60-140 (usually), on the lower surfaces of submerged objects projecting from the bottom sufficiently to allow access of the female's body. They "may be scattered over an area 12 inches or more in diameter or crowded together in a space only 6 or 8 inches square. The eggs are deposited one at a time and are attached by a circular, disk-like expansion of the outer envelope, some 5 or 6 mm. in diameter. There is a slight constriction below the attachment disk when the eggs hang in natural position buoyed up by the water but this lengthens to a slender stalk when the support to which the eggs are attached is lifted above the surface . . ." (Bishop, 1926, pp. 15-16).

*Spermatophores:* Fertilization, as in all other salamanders of North America save *Cryptobranchus* and the Sirenidae, is internal. Bishop (1932) has described their spermatophores recently for the first time:

The spermatophore consists of a gelatinous basal part supporting an apical, milky-white sperm mass. These parts are enclosed within a thin tube of clear jelly which becomes more tenuous where it passes over the sperm mass and continues from either end as a slender string. The continuation of the tube at the apical end of the spermatophore is at one side. The gelatinous basal part may be oval in outline or distinctly vase-shaped and there is no suggestion of a broad base for attachment as in the spermatophores of *Ambystoma maculatum*, *Triturus viridescens* and others. The terminal portion containing the spermatozoa is frequently whorled in two or more turns. A characteristic feature is the presence, in the basal part, of many small hexagonal crystals, apparently carbonate of lime.

The tube-like envelope which surrounds the spermatophores and which with a small amount of enclosed jelly forms the connection between the spermatophores deposited in strings, suggests the sperm string of *Cryptobranchus*. It may also indicate that the spermatophores of *Necturus* are normally produced in strings and that when dropped singly they have simply been pinched off by the vent. The lack of a broad base for attachment also suggests the possibility of direct transference of the sperm mass to the female in a venter to venter copulation.

Single spermatophores vary in length from 10 to 12 mm. and in diameter, across the widest part of the apical portion, from 6 to 8 mm.

**Development:** About 5-6 weeks are required for the eggs to hatch. Bishop (1926) correlates size with age as follows:

	Minimum	Maximum		Minimum	Maximum
First year -----	49.0	64.0	Fourth year -----	130.0	167.0
Second year -----	70.0	95.0	Fifth year -----	169.0	210.0
Third year -----	97.0	128.0			

The length may increase to as much as 432 mm.

**Breeding habits:** Fertilization occurs, probably, in the fall or winter, for, although the process has never been observed, the spermathecae of females contain spermatozoa at that time.

Ovulation occurs in the spring (probably, in Kansas, between May 15 and June 5, varying with temperature), and may continue for a week or so. Bishop (1926, p. 18), observing the process of egg-laying of a certain female, stated that she "turned herself upside down and supported her body with the toes of the front feet resting against the edge of the stone." In this position the females apparently remain until the eggs are deposited—a length of time varying with temperatures from a few hours to as many days. They may then remain in the immediate vicinity to guard the eggs. During this entire period the males are scarcely to be found. Where they remain is a matter of conjecture.

**Habits:** *Necturus* is wholly nocturnal in habit. Various authors have demonstrated that they are negatively phototropic.

In poorly aerated water or in water warmer than that to which the animal is accustomed, the gills are kept in constant motion. In clear, cold, well-aerated water they are often held motionless for long periods against the sides of the neck. Under such conditions the blood supply is restricted, the bright crimson fades to a dull ruby red and the animal is quiet. When the oxygen supply of the water is low the animal at frequent intervals rises to the surface, gulps in a mouthful of air and sinks again to the bottom. Part of the air thus obtained passes out through the gill clefts and the remainder, in some instances at least, is taken into the lungs. The skin also functions in respiration and is well-supplied with blood, particularly in the region of the tail. Judging by the action of animals under the conditions outlined above, it seems probable that the skin alone may furnish the necessary oxygen in well-

aerated water, that the gills are used under ordinary stream and lake conditions and that the lungs are called into service as a last resort.

When a living specimen is exposed to the air, complete drying of the skin is prevented for a considerable time by a copious production of slime which pours out of the dermal glands and completely envelops the body. The animal gasps for breath but in the course of a few hours dies, the lungs alone being unable to furnish sufficient oxygen. In water, however, the animal may live without apparent discomfort with the gill filaments entirely lost. (Bishop, 1926, pp. 9-10)

Their voracious feeding habits are attested by the frequency with which they are captured with hook and line. Ruthven, Thompson and Gaige (1928) state that "Specimens in captivity will snap at any moving objects and if hungry enough, will eat small pieces of meat moved about in the water." Pearse (1921) found "Arranged in the order of their importance the chief foods eaten by the mud-puppy are as follows: Crayfishes 38.1; plants 17.9; insect larvae, 17.2; fish 12.5; snails 7.2; sticks 4.4; leeches 2; cladocerans 1; sedimentary debris 0.3; ostracods +; amphipods +." Hamilton (1932) found that their diet included crustaceans, insects, fish, annelids, mollusca and amphibians (in order of quantity eaten). Several small salamanders, sculpins and various minnows, and a few of their own cast skins were included in the stomach contents. Bishop (1926, p. 17) states that they may eat eggs of *Cryptobranchus*.

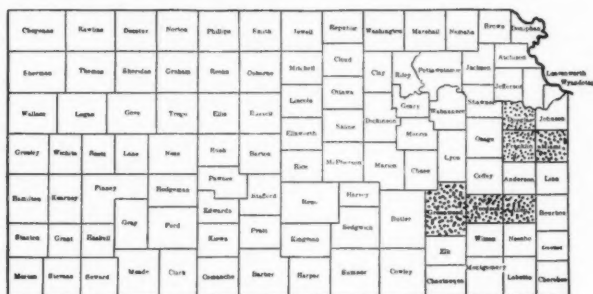
Unlike many other amphibians, *Necturus* is active throughout the winter. In regions where they are most numerous, they are secured in largest numbers in shallow water during the winter months, being taken with seines or hook and line. During summer and fall they are seldom seen in shallow water, and during spring only females, which remain to lay their eggs and guard their "nests."

Most fishermen have the erroneous belief that they are extremely poisonous, and for that reason kill them. On the other hand, they do eat the eggs and young of fishes whenever the opportunity is offered, although possibly not to a harmful extent. A thick mucous secretion is frequently emitted when the creature is handled or irritated, and their bite may be rather painful, although not serious. Various authors have reported that their flesh is white and serves as excellent food. Pearse (1921) gives recipes for preparation of them for the table.

*Habitat:* In Kansas the mud-puppy has been recorded only from streams such as those from which it must have derived its common name. It is probably much more widely distributed in the state, both ecologically and geographically, than the present records would indicate, as Bishop (1927, pp. 30, 32) states that the most favorable conditions are found in streams whose bottoms are covered with objects for nesting sites and protection.

So exacting are the requirements of egg-laying females that by examining the stream bottom the experienced collector may predict with considerable success the presence or absence of specimens. The amount of available food in the stream is a factor governing the abundance of individuals only when the stream provides suitable hiding places and nesting sites.

*Distribution:* "Tributaries of the Great Lakes, the Mississippi River system, the upper Hudson River, and Lake Champlain. Rivers of North and South Carolina, Georgia and Alabama." (Stejneger and Barbour, 1923)

Map 7. Distribution of *Necturus maculosus maculosus* (Rafinesque).

KANSAS: Probably over the entire eastern fourth of the state. Actual records are as follows:

ALLEN COUNTY (KU 3471): near Iola (Cragin, 1885a and b). DOUGLAS COUNTY: Lawrence (KU 947). FRANKLIN COUNTY: Marias des Cygnes River (Gloyd, 1928; OU 325, 326; KU 805). GREENWOOD COUNTY: Fall River (KU 16913). MIAMI COUNTY: Ossawatimie, Marias des Cygnes River (KU 812). WOODSON COUNTY: Neosho Falls (Cragin, 1885 a and b).

Remarks: First reported from Kansas by Cragin (1885a). In only one other paper [aside from the second paper by Cragin in 1885(b)] has the species been reported within the state (Gloyd, 1928).

### *Scaphiopus bombifrons* Cope

#### CENTRAL PLAINS SPADEFoot TOAD

*Scaphiopus bombifrons* Cope (1864, p. 53).

*Spea bombifrons* Cragin (1881, p. 120). In hypothetical list.

*Spea hammondi bombifrons* Cope (1889, pp. 306-308, pls. 21, fig. 17; 68, fig. 1a).

A complete description.

Cope (1893, p. 333).

*Scaphiopus hammondi bombifrons* Dickerson (1913, pp. 61-62, pl. 9). General discussion.

Burnett (1924, p. 2). Taylor (1929, p. 65). Strecker (1910, pp. 17-19, fig. 1).

Ellis and Henderson (1913, pp. 51-52). Gilmore (1924, pp. 1-12).

*Scaphiopus hammondi* Goldsmith (1926, pp. 369-370)

Slevin (part.) (1928, pp. 84-87). Kellogg (1932, p. 36).

Type locality: Fort Union on Missouri River, Lat. 48 degrees N.

Diagnosis: A *Scaphiopus* with rounded, not elongated, inner metatarsal tubercles; tip of fifth toe frequently blackened and corneous; anterior interorbital region swollen, convex; parotid glands indistinct, tympanum also usually; toes nearly fully webbed, fingers very slightly; pupils vertical.

Comparisons: The vertical pupil and the convex anterior interorbital region are absolutely distinctive of this salientian, among the Kansas forms. It differs from the *Bufo*s in the absence of a distinct parotid gland, and from

the remainder of the Kansas anurans by the presence of a large cornified inner metatarsal tubercle with a free cutting edge.

*Description:* Outline of head, from above, oval; snout projecting slightly; nostrils near tip of snout, latter protruding beyond lower jaw; distance between inner margins of nares somewhat greater than interorbital distance; distance between naris and orbit about  $1/3$  to  $1/4$  the diameter of the latter; diameter of orbit about  $1/3$  of its own diameter greater than the distance from its anterior margin to the tip of the snout; canthi rostrales slightly concave; margin of upper jaw, viewed laterally, concave below, sometimes nearly straight; tympanum usually rather indistinct, oval, the dorso-ventral diameter greatest, and about  $1/2$  the distance between nares; a groove from the posterior margin of the eye curving backward over tympanum, usually leaving a dorsal fold over the latter, and terminating at the axilla; pupil of eye vertical; upper part of lower eyelid, except a narrow border about margin, nearly transparent, apparently capable of being withdrawn behind the lower part of the eyelid like a shutter; anterior part of interorbital region swollen, convex; area between interorbital boss and nasal boss concave; tongue round, about half the diameter of the jaws, attached in front; choanae separated by a distance almost exactly equal to that between external nares; vomerine teeth between choanae, in two small series, sometimes round, usually slightly elongate and directed obliquely caudad; fingers short, slightly webbed, 2 and 4 longest, and of about the same length, 3 and 5 shorter and also of about equal length; a conspicuous large outer metatarsal tubercle, not corneous; tibiae much shorter than femora, not touching when legs are flexed and femora at right angles to the body; femoro-tibial articulation, on flexed limb, extending to tip of second toe; toes nearly fully webbed, the ultimate phalanx of the fourth but narrowly so; tip of first digit frequently corneous, occasionally some of the others also; a black, corneous, inner metatarsal tubercle, slightly broader than long to about two-thirds as broad as long, attached diagonally at an angle of about 45 degrees to the foot; skin of limbs, on middle of back and on head comparatively smooth; skin in dorso-lateral region sparsely rugose, the projections (in preservative) white-tipped; ventral surfaces smooth; a few whitish papillae in anal region.

Color above grayish, very coarsely reticulated with darker; venter whitish, immaculate, except in gular region of males, which is blackish; two series of dorsal stripes, the inner originating behind the orbits and converging to the scapular region, separated there by approximately the interorbital width, and then diverging slightly backward, forming an oval space in the mid-lumbar region, and terminating in the posterior lumbar region; the outer stripes originating above axillae, continuing along sides to the pre-inguinal region, disappearing there; a light patch extending from gular region to behind tympanum. Limbs grayish above, femora somewhat mottled.

*Sexual dimorphism:* Males have blackish throats and cornified fingers. The second and third fingers are always distinctly cornified, while the fourth and fifth are occasionally so. The interorbital boss is not a character of sexual dimorphism, as females possess the character as well as males. The

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cornified tip of the fifth toe is, although variable in appearance, not a sex-limited character. It is frequently more distinct in females than in males in collections from certain areas.

*Variation:* Frequently specimens are found with the tip of the snout, or the top of the head from the snout to the interorbital boss, or even not only the head but also a broad dorsal band (Dickerson, 1913, p. 62), with blackened, cornified tissue, probably of service in burrowing. The rugosity of the dorsal surfaces is variable, although it is never developed to the extent shown in *hammondii*. The color pattern varies in distinctness, the light bands frequently being absent, so that the body is unicolored above. The interorbital boss is in no way associated with this corneous tissue in its variability; the boss is always present, whether the top of it is corneous or not.

TABLE 11  
Measurements of adults

	1	2	3	4	5	6	7	8	9	10	11	12	13
Body length	54.0	50.8	50.6	47.0	52.0	46.0	56.1	50.2	53.0	56.0	54.9	45.7	49.5
Head width	21.7	20.8	20.0	18.5	22.0	20.8	22.0	20.0	20.0	20.3	20.0	19.2	20.1
Fore leg	26.0	27.0	25.0	25.0	28.0	24.7	25.5	23.2	26.0	27.5	27.5	22.0	23.0
Femur	21.0	20.0	20.0	19.5	22.5	19.0	20.0	20.0	19.0	19.5	22.0	17.0	16.5
Tibia	15.5	15.5	14.0	14.5	17.0	15.0	15.1	15.2	15.0	15.5	17.2	13.4	15.0
Tarsus	6.9	7.0	6.9	6.9	7.0	6.9	6.9	6.9	6.8	7.1	7.2	6.2	6.8
Whole foot	26.0	27.0	24.0	25.0	26.1	25.0	27.3	26.1	27.0	28.0	28.4	22.3	24.8

Nos. 1-6 are from Nekoma, Rush county (KU 5380-5375); nos. 7-13 are from 10 mi. N. of Elkhart, Morton county (KU 5217-5211).

*Description of larvae:* (Grants, Valencia county, New Mexico. July 31, 1930. EHT) Labial disk surrounded by a single, continuous row of papillae, interrupted but slightly at the upper margin; a single row of teeth in upper labium, separated slightly medially; teeth in lower labium in three series on a side; first series short, extending laterally about half the length of the lower mandible, almost in contact medially, slightly convex below; third series very short, widely separated, about  $\frac{1}{4}$  the length of the second series, placed near lateral tip of the latter; upper mandible with a median hook on anterior edge, edges serrate; a rounded median projection on the posterior margin, longer than hook on anterior margin, but not pointed; lower mandible about twice as broad as upper, with a median notch on anterior edge, bordered laterally on each side by a sharp projection; entire anterior edge serrate, posterior edge smoothly rounded; a cornified, black conical projection protruding from the roof of the mouth toward the oral opening; outline from above, of the body, rather egg-shaped, the greatest diameter at the angles of the jaws; eyes closely approximated, much nearer each other than the lateral margins of the body; distance between nares and from nares to the orbits about equal to the diameter of the latter; nares about  $3\frac{1}{2}$  times as far from snout as from eyes; inter-narial space about  $\frac{2}{3}$  of interorbital space; spiracle sinistral, latero-ventral in position, below tail musculature (projected); anus median, opening in basal portion of caudal fin; tail pointed, the greatest diameter of the caudal fins at about the median point of tail, and about equal to diameter of musculature at base of tail.



Pigment absent in preserved specimens; skin almost transparent, viscera plainly visible.

*Description of eggs:* According to Gilmore (1924), "The egg masses vary in size. Large masses contain 200 to 250 eggs, smaller ones 10 to 50. The mass is attached to submerged vegetation, or to any object protruding from the bottom. The mass is elliptical in shape." This description, however brief, yet indicates a difference from *hammondii* in the number in each mass and the shape of the latter. A more complete description should yet be made.

*Song:* Gilmore (1924) says, "The effect has been described as 'weird plaintive cries,' hoarse and woeful." The individual song resembles that of *Rana palustris*. The call of *hammondii* has been likened to (Ortenburger, 1925) "a loud purr of a cat but at the same time having the metallic mechanical sound of grinding gears." Kellogg (1932) states that "The call of this toad is quite weird and unusual, and may be likened to the squawk of some animal when severely injured, or a resonant *ye-ow*. Once heard this distinctive call is not likely to be forgotten." The males sing while floating in the water, with legs outstretched and vocal sacs distended. The latter is divided, as in *hammondii*, and is broader than long.

*Breeding habits:* Gilmore (1924) reports that the rainy season is usually rather short near Colorado Springs, where his observations were made, and usually during the latter part of spring and first of summer. They have been observed by Dr. E. H. Taylor to breed in Morton county as early as June 8, and as late as August 8: "Specimens were taken . . . after very heavy rain-falls. Large numbers congregated at breeding places. Three such groups were found in a radius of two miles and more than fifty specimens were taken on each of the two dates." Claspings pairs were observed upon both occasions, and, although no eggs were noticed in the pools, they were found, upon dissection, in the females captured. It is probable that they breed at any time coincident with the first heavy showers after the middle of spring, even though it be so late as the last of summer. It has never been proved that they lay more than once a year.

Temporary pools alone are chosen for breeding purposes. Goldsmith (1926) has indicated that the voices of the first arrivals at such pools probably attract numerous others, from considerable distances, which otherwise would quite possibly be unable to find suitable pools.

Gilmore (1924) further states that "very soon after reaching the water, mating begins. The males grasp the females just in front of the legs. The process of mating and egg-laying occupies from twenty-four to forty-eight hours. If rains continue the adults may remain in the water for several days; but more commonly they leave the pond immediately after the eggs have been laid."

Amplexation is normally inguinal.

*Development:* Gilmore (1924) gives a more or less complete account of development, from which the following is quoted:

The incubation period as observed in the field seems to be less than forty-eight hours. This is probably due to the very warm condition of the water. In 1924, long continued cloudy weather retarded the hatching.

The newly hatched tadpole is a trifle less than one-fourth of an inch in length. Within less than five days it has doubled in size. Within another five days it has attained a length of one inch. The legs then begin to develop. Fifteen days later it has reached its maximum size. Two and one-half inches is the maximum length of the majority of adults in any tadpole community. A small minority attains three to three and three-quarters inches in length. At about the thirtieth day after egg-laying, arms begin to appear, and the process of transformation begins to be evident in all parts of the animal. The complete absorption of the tail and the completion of remodeling of all structures into adult form is accomplished by the fortieth day. . . . In 1921, specimens were found to be completely transformed after thirty-six to forty days. In 1923, the shortest observed period was thirty-nine days. . . . At no time during the season of growth are all tadpoles of even approximately the same size. From ten to twenty percent of specimens known to have hatched at the same time are considerably larger than the average. Some may be two to three times the size of the average. These larger forms are frequently found with smaller ones half-eaten.

Dr. Taylor has found larvae of this form in New Mexico with small partially devoured tadpoles in their mouths.

*Food:* Gilmore (1924) has made some very interesting observations with regard to the food of the tadpoles.

The spadefoot chooses temporary ponds in which to rear its young. In no cases have eggs or tadpoles been observed in permanent lakes, although such lakes are available. The ponds are road-side mud-holes and low areas in fields ranging from a few inches to a few feet in depth. The water is muddy and warm. The vegetation consists of such microscopic plants as have passed the winter in a resting condition in the dried mud at the bottom. A few plants of *Marsilea*, some of the coarser grasses, sedges and rushes may be present. To the casual observer the ponds seem unusually barren. The animal life is rich and varied. Protozoa are present in abundance. Rotifera are common. Various of the smaller worms are abundant. The larvae of aquatic beetles, bugs and diptera are present in small numbers. The dominant fauna consists of crustaceans. Of the phyllopods several species of shrimp are numerous (*Streptocephalus*, *Thamnocephalus*, *Apus*, *Estheria*). Of the Cladocera, *Daphnia* and other genera are represented. These attain to unusual size and abundance. Of the Copepods, *Cyclops*, *Diaptomus*, and other genera are abundant.

In this environment, poor in larger plants, rich in animal life, the spadefoot tadpole develops. This may account for the development of the carnivorous habit.

The structures about the mouth of the spadefoot tadpole are admirably adapted for a diet of living animals. The horny jaws are constructed for seizing and holding prey. They are capable of being opened to accommodate large prey. On the roof of the mouth is a median horny recurved tooth. This is not found in herbivorous tadpoles. The lips. . . are flat and thin and probably assist in the capture and holding of prey. Food is not swallowed whole as in the adult toad, but is held in the jaws and sucked or torn to bits.

The feeding apparatus is operated by an unusual development of mouth muscles, an adaptation probably associated with a carnivorous diet.

Cope (1889) records larvae of this form, from a lake in Idaho, engaged in eating the grasshoppers, and I detected several specimens with the entire insects in their mouths. In some instances the grasshoppers' bodies were too large and projected from their mouths. These precocious larvae were evidently air-breathers, and hopped about presenting a curious appearance as they dragged their large tails after them.

Quoting further from Gilmore (*op. cit.*):

The tadpoles of most frogs and toads are herbivorous and therefore have very long intestines. As they transform to the adult condition they take only animal food, and the long intestine is replaced by a short one. In the spadefoot the change from

a long to a short intestine seems to take place before the beginning of transformation. In fact, some specimens seem never to have had a long intestine. It seems probable that the spadefoot tadpole is departing from the traditions of its ancestors and relatives and adjusting itself to a new type of diet. This adjustment is approaching perfection in the jaws, lips, roof of the mouth, and jaw muscles. The long intestine character has not been eliminated, but is in process of elimination. It seems to persist during early tadpole life and is later supplanted by a short intestine. The short intestine character will be subject to a wide range of variation until it has firmly established itself on the race.

The food of adults is probably insects and their larvae, as has been shown (Tanner, 1931) in *hammondi*. Beetles, crickets, grasshoppers and ants predominated, with a few miscellaneous creatures found in stomachs occasionally. The nature of this food would indicate, as would be expected, that the adults feed after dark.

*Habits and habitat:* It has generally been considered that spadefoot toads in the west appear only during the time of heavy rains in the warmer portions of the year, at which time they breed, only to return to and remain in their subterranean retreats for the remainder of the year. This belief is probably due to the fact that during this time of breeding the toads can be located in congress by their calls, and it is largely under such conditions that they have been collected. Even so, "if the observer does not happen to be on hand at the right time and in the right place, the animals will escape observation entirely" (Storer, 1925), for the period is, according to Gilmore (1924), of but about 24-48 hours duration. It is probable that after breeding they scatter widely, and since they do not sing, when they do emerge merely for food, it is seldom that they are found. How frequently they do come out at night is not known, but the writer has observed adults at night in the sand dunes near Medora, Kansas, hopping about in considerable numbers in light showers. The evening following this particular one was clear, and only a single specimen, an adult, was secured. Kellogg (1932) indicates that the young may emerge at night, during the summers, entirely independent of rains. The following interesting notes are quoted from him:

In suitable sandy areas, this nocturnal spadefoot comes out of its burrow during the summer months after it gets too dark for one to see objects without the aid of a flashlight. Along the Powder River near Powderville in Montana, on June 15, 1916, while lying upon my cot, I heard a curious rustling in the dry leaves about our tent. Upon investigation with a flashlight many small spadefoot toads were found. They were hopping about in the dry leaves which were scattered about the sandy soil. When hunted with a flashlight they endeavored to burrow out of sight and but a few minutes were required for them to entirely conceal themselves. These spadefoots make circular holes in the ground and yet in sandy soil it is very difficult to find the place where they have burrowed down, for in most cases it seems as if they pulled the hole in after them. After the breeding season is over, they take more pains in constructing their burrows as they are well rounded and resemble somewhat an earthen jar with a narrow top. Around this opening there is present some sticky matter which may aid in the ensnaring of insects. I have usually found this toad most plentiful in sandy areas, especially along the banks of streams though they occur on the elevated plains from Kansas to Montana.

In burrowing their habit is to sink backward into the sand, digging from the rear by means of the "spades" on the hind feet, sidling back and forth and shuffling the hind limbs in quick and erratic movements which enable

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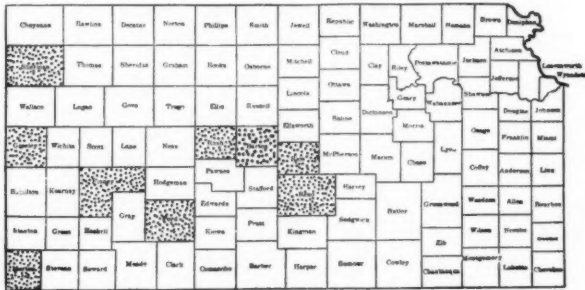
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the creature to conceal itself below the surface of the ground in but a few moments. They are strongly negatively phototropic, and will frequently begin to burrow as soon as light is shone upon them (when not breeding). They may also frequently be stimulated to emerge from their subterranean retreats in the laboratory by placing them in darkness.

A practical value in the "window" of the lower eyelid is difficult to conceive. It is probably not associated with any distinctive habit, as many other salientia possess similar structures.

*Scaphiopus*, in combination with its digging equipment, has other characteristics which would seem of decided benefit to an amphibian living amid arid surroundings. The voice of the male at spawning time is very loud, equaling or exceeding that of *Hyla regilla* and many times stronger than that of *Bufo b. halophilus*. Upon the advent of rain in amount sufficient to form pools we may expect that the first male *Scaphiopus* to enter a rain pool would begin calling; this would serve to attract females and other males so that a breeding colony would be established quickly. Rain pools do not necessarily always form in the same place in successive years. If, as we have reason to suppose, the adults are more or less scattered when in their burrows, the strong voice of the first male entering a pond suitable as a breeding environment would serve to concentrate the local population there. Once concentrated, spawning is evidently accomplished with speed as indicated by the large numbers of eggs in similar stages of development found in the ponds near Santa Maria following the first heavy late spring rain. The embryonic developmental period is found to be short. The larval period is probably also short if we may judge by analogy from the known facts in the case of the other two widely distributed species of *Scaphiopus* in the United States. The newly transformed young spadefoot has at once the burrowing reflex of the species, which it must, in the case of prairie ponds lacking a border of aquatic vegetation as temporary shelter, put to immediate use to protect itself from desiccation. (Storer, 1925).

**Distribution:** States east of the continental divide south to northern New Mexico, including the northwestern part of Texas, and the western parts of the states of Oklahoma, Kansas, Nebraska, South and North Dakota.



Map 8. Distribution of *Scaphiopus bombifrons* Cope.

**KANSAS:** Probably over the entire western half of the state. Actual records are as follows:

**BARTON COUNTY:** (OU 1022). **FINNEY COUNTY:** Garden City (KU 5201-5207). **FORD COUNTY:** Spearville (OU 165). **GREELEY COUNTY:** 9 mi. NE of

Tribune (KU, 1 spec.). MORTON COUNTY: (KU 7179, 7180, 7182); Elkhart, 12 mi. N. of (Taylor, 1929; KU 5208, 5211-6267, 6295-6334; EHT 14 spec.; exhibition collection, 1 spec.). RENO COUNTY: Sand dunes near Medora (KU 16295-16297). RICE COUNTY: (KU, 1 spec.). RUSH COUNTY: (KU 3502-3503, 3505-3506, 3508-3518, 3520-3521); Nekoma (KU 5268-5430). SHERMAN COUNTY: Goodland (KU 5209).

*History:* The species has been reported in the state but once (Taylor, 1929), from Morton county.

*Remarks:* The status of *bombifrons* has long been one of dispute. It has been considered as a synonym of *hammondii* by several recent authorities (Stejneger and Barbour, 1923; Slevin, 1928; Ortenburger and Freeman, 1930). During the course of this study nearly 650 specimens have been examined, and from these it has been concluded by the writer that the form is a distinct species. Material has been examined from the following localities, aside from Kansas:

*hammondii:*

ARIZONA—PIMA COUNTY: Flat near Santa Rita Mountains (KU 14574). COCHISE COUNTY: Don Lius, near Bisbee (KU 10202-10205); near Don Luis (KU 10217-10239). NEW MEXICO—CATRON COUNTY: 5 mi. N. of Glenwood (KU 6669-6730). GRANT COUNTY: Silver City, 10 mi. SE. of (KU 15655, 15657, 15658). LUNA COUNTY: Near Florida (KU 10207-10215). VALENCIA COUNTY: Grant, 15 mi. E. of (KU 14547-14566, 14569-14572); near Inscription Rock (KU 14538-14546; 8 spec.). OKLAHOMA—WOODS COUNTY: Alva (KU 10216). TEXAS—BREWSTER COUNTY: Alpine (KU 10240-10309).

*bombifrons:*

IDAHO—BANNOCK COUNTY: Pocatello (KU 14567). NEW MEXICO—GRANT COUNTY: Silver City (KU 15657). UNION COUNTY: near Clayton (KU 14573). VALENCIA COUNTY: near Grant (KU 14568); near Inscription Rock (KU, 2 spec.). OKLAHOMA—CLEVELAND COUNTY: 2 mi. N. of Lexington (EHT and HMS 101-134). PAWNEE COUNTY: Cleveland (KU 16021-16026). SOUTH DAKOTA—HARDING COUNTY: Buffalo (KU 5196-5200).

The following points have been considered in separating the two forms:

1. Presence or absence of an interorbital boss. The presence of an interorbital boss, coupled with a rounded, not elongate, metatarsal tubercle, is alone a character which distinguishes *bombifrons* from all other species of *Scaphiopus*. *Hurterii* resembles *bombifrons* to some extent in the possession also of an interorbital boss, but in this species it is posterior to the eyes, while in *bombifrons* it is between them. The metatarsal tubercle in *hurterii* is elongate, not rounded as in *bombifrons*.

In both *hammondii* and *bombifrons* there is a glandular area about half-way between the eyes and the tip of the snout, which is developed to varying degrees. In some specimens of the former species it is so highly developed that at first glance it appears that a true osseous boss is present. In *bombifrons* the glandular area is an anterior continuation of the true osseous boss, and usually considerably amplifies its appearance externally. In case of doubt as to whether the swollen appearance is due merely to hypertrophy of the glandular area, as seen in a few specimens of *hammondii*, or to the actual presence of an osseous boss, the swollen appearance being augmented by the glandular area, but not due to it alone, it is necessary to remove the flesh

from the frontoparietal bones in the interorbital region, where the osseous boss, is present, will occur. It is probably due to the presence and variability of the glandular area on the snout that the two forms have in the past been considered somewhat variable with respect to the true boss, and thus worthy of no or but subspecific recognition. All variability, however, apparently rests in the glandular area, and not in the osseous boss, the true basis for recognition of *bombifrons*. Variations of the former may occur in either, although it apparently never produces such obvious protrusions in *hammondii* as in *bombifrons*. In fact, the latter seems to be very stable with respect to the external appearance of the interorbital boss.

2. *The character of the larval mouthparts.* The mouthparts of the larvae of the two species are remarkably different. Compared with the mouthparts as figured by Storer (1925, p. 39, fig. EE) and Wright (1929, pl. 1, fig. 3), those of *bombifrons* differ in the possession of a large beak in the upper mandible and a deep, elevated notch in the lower. A median conical horny tooth in the roof of the mouth of the latter species is a further characteristic. These differences are so marked that there can be little doubt of their specific value.

3. *Degree of rugosity in adults.* *Hammondii* is the more rugose species. Some specimens of it are as "warty" dorsally as true toads, although the individual protuberances are proportionately larger, more uniform in size and less corneous. Most of them are, however, capped with microscopic black, corneous spines, especially above the axillae.

*Bombifrons* is not so rugose, and but few of the individual prominences are capped with black corneous spines. Rugosity in general, however, may perhaps be variable with ecological conditions, and alone cannot be relied upon as a specific character. Nevertheless the general tendency of the western form to be more rugose adds further weight to the separation of it from the eastern species.

4. *Internarial distance.* A broad snout, with widely separated nares, is characteristic of *bombifrons*. In this species the internarial distance is usually very distinctly greater than ( $1\frac{1}{2}$  times) the distance from the eye to the naris of the corresponding side; in *hammondii*, as a rule, they are about equal, although again there is considerable variation, a few specimens having widely separated nares. This may or may not be associated with swollen glandular areas of the snout in the latter species. Either condition is rare, and a combination of the two is still more rare.

5. *Presence of corneous tips on the first and succeeding toes.* In *bombifrons* of the north, the tip of the first toe is apparently invariably black and corneous. This condition, however, becomes more and more variable to the south, until in Oklahoma it occurs only in about 50% of the specimens. It rarely occurs in *hammondii*, and probably only on the extreme eastern limit of its range, as Storer (1925) does not mention it.

6. *Distinctness of tympanum.* In general, the tympana of *hammondii* are less distinct than those of *bombifrons*. This is, however, variable.

7. The description of the eggs of *bombifrons* as given by Gilmore (1924)



is somewhat different from Storer's description (1925) of those of *hammondi*. Further field experience will be necessary to determine the extent of the differences.

The ranges of the species overlap in southern United States as far west as western New Mexico (Valencia and Grant counties), where *bombifrons* has been taken, and as far east as western Oklahoma (Woods county), where *hammondi* has been taken. The exact range of each species north of Colorado is yet indefinite, since the forms have usually not been distinguished, and material is not available in the various museum collections examined by the writer.

***Bufo americanus americanus* (Holbrook)**

AMERICAN TOAD

*Bufo americanus* Holbrook (1836, p. 75, pl. 2)

*Bufo lentiginosus* Shaw, var. *fowlerii* (part) Cragin (1881, p. 119).

*Bufo lentiginosus americanus* (part) Cope (1889, pp. 284-288, fig. 70).

Hartman (part.) (1906, pp. 227-228).

*Bufo americanus* Gloyd (1928, pp. 116-117). Recorded from Franklin county; life history notes.

Burt and Burt (1929a, p. 381). Recorded from Montgomery county.

Gloyd (1932, pp. 395). Reported from Miami county; life history notes.

Type locality: "From Maine through all the Atlantic states."

**Diagnosis:** A *Bufo* with large, broad, closely approximated parotid glands usually separated from the postorbital ridge; warts on back large and with but one or two to a dorsal spot; body spinose, the anterior surface of the tarsi and metatarsi with black spines; venter usually spotted; song a long, high trill of some 20-30 seconds; eggs separately partitioned and enclosed in a double membranous tube.

**Comparisons:** The American toad differs from other Kansas anurans as stated in the paragraphs on comparisons under *Bufo w. woodhousii*.

**Description:** Snout somewhat pointed in profile, viewed from above; lores angular, not vertical; eyes not included in outline of head viewed from above; nares rather closely approximated, nearer each other than to either eye; tympanum  $\frac{1}{2}$  to  $\frac{1}{3}$  the size of the eye, frequently bordered posteriorly by a fold of skin; outline of jaws, viewed laterally, nearly straight, the upper jaw notched in front and the lower with a median projection; tongue about  $\frac{1}{3}$  as large as cavity of the lower jaw, smoothly oval; cranial crests always distinct, usually divergent, sometimes parallel, never filled in between to form a "plateau"; postorbital crests usually in contact laterally with tympana, frequently with an anterior branch extending along the dorsal anterior edge of the tympanum; a "spur" directed postero-medial from each corner or junction of the interorbital and postorbital crests; parotids about  $\frac{1}{3}$  to  $\frac{1}{2}$  longer than wide, separated by somewhat less than their own length, usually not in contact with postorbital ridge, sometimes in contact with tympana; dorsal warts of varied sizes, some nearly as large as or larger than tympana, all spinose; some warts on dorsal surfaces of tibiae as large as those on the body; a somewhat enlarged, brightly colored wart above and on either side of the

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anus; ventral surfaces granular or spinose; warts on dorsal surfaces of limbs and above axilla very strongly spinose; a single, double or sometimes a triple row of somewhat enlarged warts on the posterior surfaces of the forearms; numerous smooth subarticular and palmar tubercles, a large one at the base of fourth and fifth fingers, and a smaller one at the base of thumb; a large inner metatarsal tubercle with a free cutting edge; a rather minute outer metatarsal tubercle; second subarticular tubercle of fourth toe frequently divided, the first practically always; all toes nearly fully webbed, except the three terminal phalanges of the fourth; tibio-tarsal articulations not touching when femora are at right angles to body.

Color rather dark or reddish in general; a few black spots, outlined by lighter, surrounding one or two warts each on the dorsal surface; sometimes some elongated lateral blackish markings including numerous smaller warts; frequently a black, light-edged bar across each eyelid; upper labial region sometimes banded; all surfaces of limbs except perhaps ventral reticulated or banded or spotted; breast usually with numerous black spots; frequently a brightly colored patch of warts between insertion of forearm and tympanum, and one above and on each side of anus.

*Sexual dimorphism:* The throats of males are black at least during the breeding season, and their "thumbs" are cornified and enlarged, aiding in the maintenance of the embrace. Females are somewhat larger (10-20%), and their snouts in lateral profile (in Kansas specimens) are as truncate as those of either sex of *w. woodhousii*.

*Variation:* Much variation obtains in general hue, in wartiness and spinosity, in ventral coloration and in direction of the interorbital crests. Some are quite dark, so that no markings can be discerned, while others are more brightly colored, although none to the extent of *w. fowleri* or *w. woodhousii*.

TABLE 12.  
Measurements of adults

Sex	fem.	male	male	male	male	male
Head and body	91.1	59.0	72.5	68.5	74.5	68.0
Width of head	34.4	22.7	28.0	25.0	29.0	26.0
Length of head	18.0	11.5	12.5	11.8	14.0	12.0
Interorbital space	7.2	5.0	6.5	6.5	6.5	6.5
Fore leg	52.0	48.5	46.0	42.0	48.0	43.0
Femur	30.0	21.5	32.5	28.5	30.0	28.5
Tibia	21.0	22.0	30.0	25.8	29.5	27.5
Whole foot	45.2	33.0	43.0	37.5	40.0	39.0
Length of parotids	17.3	10.5	14.3	14.0	13.4	13.0
Width of parotids	9.6	5.5	8.7	9.0	7.5	6.5

All specimens from 1 mi. SW of Carbondale, Osage county (KU).

*Description of larvae:* (From Wright, 1929). Anus median; spiracle sinistral, below lateral axis (of tail musculature projected), sometimes as much ventral as lateral; labial teeth 2/3; papillae on upper and lower halves of lateral labial margin, and some inner papillae, all plainly visible; one row of weak papillae from upper fringe to end of third lower row of teeth, with a few scattering papillae at the side of the labium; lower loop with only two or three scattering papillae beside the outer row of weak papillae; mouth in in-

terorbital distance 0.77-1.0, average 0.92; horny beak in upper fringe 1.2 to 1.4; horny beak in first or second row 1.1 to 1.2 times; third row in first lower row 1.3 to 1.5; depth of tail in tail length 1.25-2.7, average 1.97; spiracle nearer eye than vent 1.04 to 1.54, average 1.28; eye nearer snout, than spiracle 1.0 to 1.27, average 1.16; mouth larger internasal space 1.4 to 2.2, average 1.76; papillae of lower labial loop do not extend under the end of the third row of labial teeth; tail musculature in tail depth 1.26 to 2.66, average 2.04; internasal space 1.2 to 1.8 in interorbital distance, average 1.6; spiracle 1.05 to 1.55 nearer eye than vent, average 1.28.

*Description of eggs:* Eggs are laid in strings, single file, in a double membranous tube with a membranous partition between each vitellus; diameter of outer tube 2.86 mm.; of inner, 2.0163 mm. (apparently double); of vitelli, about 1.43 mm. The latter are dark brown at one pole, cream-colored to white at the other. The full complement of a single female varies, probably with size, from 4,000-8,000, according to Wright and Wright (1924), to 20,603 (by actual count).

*Song:* A high, prolonged trill of some 20-30 seconds duration. Heard usually only during the breeding season.

*Breeding habits:* This and other points in the life history of the American toad have been repeatedly recorded and summarized by so many authors that it seems hardly necessary to go into detail here. Wright (1914), Miller (1909) and Gage (1904) have made perhaps the most important contributions.

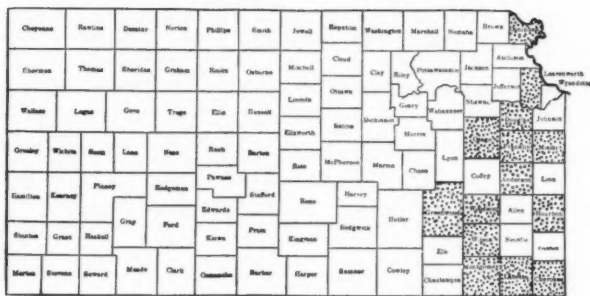
In Kansas, Gloyd (1928) reports that they were first collected on March 30, and were in full chorus by April 4, at which time clasping pairs and eggs were observed. "Young toads were undergoing metamorphosis in shallow ponds May 24 and adults were heard singing June 2." In 1929 Gloyd (1932) further reports that a full chorus was to be heard at Pigeon Lake (Miami county) on April 7, and that in 1928 they were evidently just beginning to sing on March 24. Near Lawrence, the author observed that they began singing first in 1933 on March 31; full choruses were heard from April 21-28, the season being delayed by long intervals of cold. In 1932 Dr. Taylor collected them near Lawrence at the height of their breeding activities from April 18-22. In the same year the author heard them in full chorus in Cherokee county on March 25.

These records would indicate that the height of the breeding activities is reached in Kansas generally about two weeks earlier than in Ithaca.

*Distribution:* Eastern North America west to the eastern parts of Oklahoma and Kansas, from Hudson Bay to Alberta and Labrador southward.

**KANSAS:** Probably over the entire eastern fifth or sixth of the state. Actual records are as follows:

ANDERSON COUNTY: Hyatt (KU 14250). BOURBON COUNTY: (FMNH). CHEROKEE COUNTY: Spring River (KU 6349). DONIPHAN COUNTY: Doniphan Lake (KU 6382-6385). DOUGLAS COUNTY: (KU 6346-6347; 11381-11382; 14249; 14251-14253; 15583; 4 spec.; EHT, 15 spec.) FRANKLIN COUNTY: (Gloyd, 1928; KSC 400; FMNH, 2 spec.; UMMZ 66864 (2); PC, 1 spec.; OU 142-159). GREENWOOD COUNTY: Toronto, 8 mi. SW of (KU 16314-16320; 1 spec.). LABETTE COUNTY: (KU 14288-14291); Big Hill Creek (KU 6341); Oswego, 9 mi. SW of

Map 9. Distribution of *Bufo americanus americanus* (Holbrook).

(KU 6377-6381); Montana (HMS, 2 spec.). LEAVENWORTH COUNTY: 5 mi. N. of Lawrence (KU 6339). MIAMI COUNTY: (HKG 1813-1819; USNM 5 spec. MVZ 2 spec.; UMMZ 66865, 66866); Pigeon Lake (Gloyd, 1932); Ossawatimie (KU 6350). MONTGOMERY COUNTY: Cherryvale, 4 mi. S. of (Burt and Burt, 1929a). OSAGE COUNTY: Carbondale, 1 mi. SW. of (KU 5 spec.). WILSON COUNTY: 2 mi. N. of Neodesha (KU 14211-14212). WOODSON COUNTY: Neosha Falls (KU 1 spec.).

**History:** The first accurate record of this toad in Kansas is Gloyd's report of it from Franklin county in 1928. It has since been reported from only two others: Montgomery (Burt and Burt, 1929a) and Miami (Gloyd, 1932).

The numerous previous references to *americanus* in Kansas have been ignored in this study because of general confusion with *w. woodhousii*. The first of these is Hallowell's report of 1856 (a). Since no accurate locality data accompanied his material, and he obviously confused *punctatus*, *americanus* and *woodhousii*, this report cannot be accepted in any form. The next reference to the species, by Cragin (1881) is involved in such confusion of terms that it is impossible to say what he had, as he states, regarding *americanus*, "Common at Manhattan and westward (Popenoe) should also be found eastward." Two other forms of this complex are listed: *frontosus* ("Kansas") and *fowleri* ("Manhattan and E.") Such a confusion of names and distributions is meaningless.

Yarrow's (1883) *americanus* from the Little Blue River and Ft. Riley have not been verified by the recent intensive collecting in that region by Gloyd, Burt, Dice, Jewell and others. He undoubtedly confused *woodhousii* with *americanus*. The same applies to Cope's (1889) records from the same localities. Hartman (1906) mentions it from Kansas City, but as he also has specimens from Graham county, where the species does not occur, the eastern record cannot be accepted, as *w. woodhousii* (or possibly intergrades between that and *w. fowleri*) quite likely exist there with *americanus*. Linsdale (1927) evidently confused *americanus* with *woodhousii* also, not recognizing the former, as specimens of both species from the same locality at which he worked, and collected during one of the years he was there, are in the Dyche Museum, whose collections he examined.

*Remarks:* It is necessary to add that the more recent record of *Bufo woodhousii* and *B. americanus* both in Colorado (Ellis and Henderson, 1913, p. 55, pl. 1, fig. 2) is apparently erroneous. The photographs (*loc. cit.*) of the presumed typical specimen of their "*americanus*" very clearly illustrates *woodhousii woodhousii*.

### *Bufo cognatus* Say

#### GREAT PLAINS TOAD

*Bufo cognatus* Say (In Long, 1823, p. 190).

Cope (1889, pp. 275-277, fig. 67). Recorded from "Kansas," Ft. Riley and the Little Blue River.

Hartman (1906, p. 228). Food.

Ruthven (1907, pp. 504-505). Habitat.

Strecker (1910, pp. 19-20, fig. 2). Habits.

Taylor (1929, p. 65). Recorded from Morton county.

Kellogg (1932, pp. 41-44, fig. 7). Recorded from Trego, Gove, Wallace and Morton counties.

*Bufo lentiginosus cognatus* Cragin (1881, p. 119). Recorded from Ft. Riley.

Yarrow (1883, p. 165). Recorded from Ft. Riley and the Little Blue River.

*Bufo cognatus cognatus* Storer (1925, pp. 187-192, pl. 11, fig. 31a).

Gloyd (1929, p. 44). Recorded from Riley and Geary counties.

Tanner (1931, pp. 175-177). Food.

*Type locality:* Arkansas River, Prowers county, Colorado.

*Diagnosis:* A *Bufo* of large size, with distinct, broad cranial crests uniting and forming a strong nasal boss; ridges present behind and in front of eyes, absent below; parotids short, elongate; warts on back approximately of uniform size, not arranged in any order; color pattern of large, symmetrical, distinctly outlined, usually light-edged blotches.

*Comparisons:* The coloration, combined with the presence of a strong nasal boss, is distinctive of *cognatus* among the Kansas toads. *Bufo californicus* (Camp), to which this is closely related, differs in the possession of a second smaller metacarpal tubercle; a flat inner metatarsal tubercle with no free cutting edge; a round, not kidney-shaped, vocal sac in males; much smaller size, and other differences pointed out by Myers (1930).

*Description:* Head thick, dorsal profile parabolic, lateral outline angular, because of apices as posterior angles of cranial crests, and at anterior and posterior edges of nasal boss; snout truncate in lateral profile, not or but slightly projecting over lower jaw; interorbital crests broad, more narrow anteriorly, divergent; postorbital crests broad, reaching tympana; a very small branch from postorbital crests along dorso-anterior edge of tympana, or none; a slight branch at junction of postorbital and interorbital crests; a large nasal boss from anterior portion of interorbital region to nares, sometimes with a median furrow; the interorbital crests in contact with nasal boss, narrow at that point; lores narrow, angular; parotids oval to elongate, in contact with postorbital crests, usually separated from tympana; tongue large, occupying almost  $\frac{1}{2}$  the cavity of the lower jaw, flatly ovoid; internal nares comparatively small, separated by a space somewhat greater than that between external nares; tympana rather small, oval, about equal to internarial distance; orbits large, about  $\frac{1}{2}$  the length of the head, diameter greater than the dis-

tance between them and tip of snout; forelegs nearly free from skin of body; fingers 3-2-5-4 in order of increasing length, toes 1-2-5-3-4; a large metacarpal tubercle or pad; inner metatarsal tubercle large, elongate, blackened and with a free cutting edge; a small, blackened outer metatarsal tubercle present; tubercles on palms of hand conspicuous and numerous, and subarticular ones larger; tubercles on palms of feet smooth and inconspicuous, with a few subarticular tubercles, somewhat larger; fingers not webbed, toes about  $\frac{1}{2}$  webbed, with three free terminal phalanges on the fourth toe and one on the remainder; femora proportionately short, foot long; warts on body and hind limbs of approximately equal size, those of forelimbs, in supraaxillary region and on anterior aspect of femora, smaller and more strongly spinose; snout, edges of upper jaw to below middle of eyes and lores smooth; ventral surfaces granular, with minute spines; tips of digits frequently blackened; symmetrical, dark-outlined, light-edged spots above.

Color above yellowish, with large, symmetrical, dark-outlined, light-edged brownish areas on sides and especially on back; hind limbs banded; fore limbs banded or spotted; a broad, diagonal, brownish crossbar across each eyelid; upper jaw banded; ventral surfaces yellowish, immaculate or with a few dark breast spots.

*Sexual dimorphism:* Males possess large blackish gular pouches, and their "thumbs" are more or less cornified; females are somewhat larger.

TABLE 13.  
Measurements of adults

	1	2	3	4	5	6	7	8
Length of Body	114.0	87.0	82.1	44.6	77.3	79.7	83.3	85.8
Width of head	39.0	34.2	34.0	28.0	32.0	33.1	32.1	35.0
Interorbital space	6.0	5.0	5.0	3.0	4.8	4.9	5.0	5.8
Fore leg	54.5	43.0	44.3	38.0	42.2	40.1	45.1	46.4
Femur	39.0	26.0	27.0	23.0	29.0	29.4	30.0	32.0
Tibia	29.0	25.0	26.0	21.0	24.0	26.0	26.0	26.0
Tarsus	19.0	13.0	13.0	11.5	13.0	13.0	13.5	14.0
Whole foot	48.0	43.0	41.4	35.0	39.5	40.0	41.5	46.0
Length of parotids	14.0	11.2	12.9	7.9	12.6	10.3	12.0	14.0
Width of parotids	8.0	7.3	8.0	5.1	7.3	7.2	7.0	7.9
Sex		fem.	fem.	fem.	male	male	male	fem.

No. 1 is from 18 mi. N. of Elkhart, Morton county; 2-3 are from Junction City, Geary county; 4 is from Logan county; 5-6 are from Nekoma, Rush county; 7-8 are from Little Salt Marsh, Stafford county.

*Larvae:* Unknown.

*Eggs:* Unknown.

*Song:* Myers (1930) states that the "call of *cognatus* is a trilled rattle, with much of the timbre of *Acris* in it." The call of individuals I have heard in Oklahoma and Mexico was a long-continued, raucous trill of a metallic nature suggestive of grinding gears. The vocal sacs of males are enormous and kidney-shaped when inflated, extending out in front of the head.

*Breeding habits:* Females collected in Morton county on June 30, 1928, contained large numbers of eggs; others collected in Kansas in August and late July had laid their eggs.



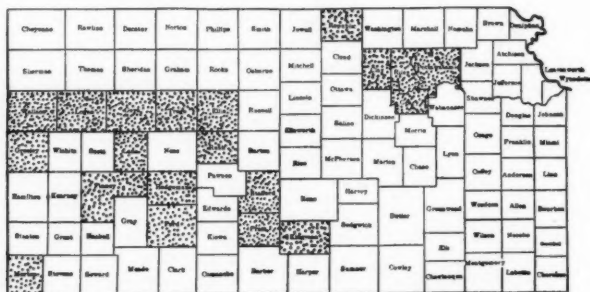
*Development:* Strecker (1910) states that "They breed in temporary pools as well as permanent springs and small streams and the metamorphosis of the tadpole is said to take less than two weeks." Dickerson (1913) states that "Judging from the series of decidedly different sizes of this toad found in the spring, at least five years must be required for full growth to be attained." Storer (1925, p. 191) concludes that at least four years and probably five are required.

*Food:* Hartman (1906, p. 228) states that "The specimens examined contained snout beetles and dung-beetles." Tanner (1931, p. 176) indicates that they feed primarily possibly on ants, with occasional beetles and beetle larvae added.

*Habits and habitat:* Ruthven (1907, pp. 504-505) states that this species "was commonly found at dusk about the irrigation ditches, but not elsewhere." Strecker (1910) adds that "During wet seasons, these toads are found in low places on the plains in enormous numbers and hundreds are killed by wagons in ruts in the road. . . . It is more diurnal in habits than most toads. On cloudy days we found active specimens in the streets as late as eleven o'clock in the morning and as early as three in the afternoon, and at the springs at all hours of the day. Usually, however, they come out of their burrows about an hour before dusk. These burrows are located in sandy soil at the roots of bushes and weed clumps."

Amplexation is presumably axillary or subaxillary, as is characteristic of most *Bufo*s.

*Distribution:* Southern Wyoming and North Dakota south on the east through central Kansas, to eastern Arkansas and Texas, west to Arizona and Utah.



Map 10. Distribution of *Bufo cognatus* Say.

KANSAS: Probably over the entire western and central part of the state, excluding the eastern fourth. Actual records are as follows:

CLAY COUNTY: Clay Center (UMMZ 66853). ELLIS COUNTY: (L. A. Brennan, MSS; HMS, 1 spec.). FINNEY COUNTY: 18 mi. N. of Garden City (KU, 2 spec.). FORD COUNTY: (OU 169). GEARY COUNTY: (Gloyd, 1929): Ft. Riley (Cragin, 1881; Yarrow, 1883; Cope, 1889; USNM 2267); Junction City (KU 5908-5909).

GOVE COUNTY: (USNM 57500; KU 5898; Kellogg, 1932b). GREELEY COUNTY: 9 mi. NE of Tribune (KU, 2 spec.). HODGEMAN COUNTY: Jetmore (OU 160-168). KINGMAN COUNTY: Kingman (KU, 1 spec.). LANE COUNTY: Pendennis, 1 mi. N. of (KU 5902-5904). LOGAN COUNTY: Elkader, 5 mi. S. of (KU 5901). MORTON COUNTY: (Kellogg, 1932b; KU 5897); 18 mi. N. of Elkhart (Taylor, 1929; KU 5894, 5896). POTTAWATOMIE COUNTY: (USNM 88947-88948). PRATT COUNTY: Pratt, 3 mi. N. of (KU 5939; 10 spec.). REPUBLIC COUNTY: Agenda (KU 5895). RILEY COUNTY: Manhattan, 5 mi. NE of (Gloyd, 1929). RUSH COUNTY: (KU 3497-3499); Nekoma (KU 5884-5893, 5905). STAFFORD COUNTY: Little Salt Marsh (KU 5874-5883). TREGG COUNTY: (KU 5899-5900, 5910-5923; Kellogg, 1932b); 12 mi. S. of Collyer (KU 5906-5907). WALLACE COUNTY: (Kellogg, 1932b; KSC 41-47).

*History:* Cragin reported this form from Kansas first in 1881, from Ft. Riley. In 1883 Yarrow added the Little Blue River, Kansas (Washington or Marshall counties). Cope (1889) recorded it from both localities but gave no new ones. Recent records were made in 1929 by Gloyd, from Riley and Geary counties, and by Taylor, from Morton county. Kellogg (1932) mentions the species from Trego, Gove, Wallace and Morton counties.

### *Bufo debilis* Girard

#### DWARF TOAD

*Bufo debilis* Girard (1856, p. 87).

Cope (1889, pp. 264-265, fig. 51).

Cope 1893, p. 332). Notes on habitat and song.

Cragin (1895). Recorded from Morton, Hamilton and Barber counties, Kansas.

The first state report.

Ellis and Henderson (1913, pp. 53-54). Recorded from Las Animas county, Colorado.

Strecker (1908, p. 81). Recorded from McLennan county, Texas. Incidental notes.

Dickerson (1913, p. 112).

Van Denburgh (1924, p. 196). Recorded from Guadalupe county and Hatchet Ranch, New Mexico.

Strecker (1926b pp. 8-12). Habits.

Taylor (1929 p. 65). Recorded from Morton county. Habitat.

Hill (1931, pp. 547-548). Mentioned from Morton county.

Kellogg (1932b, pp. 50-53). Recorded from Morton and Grant counties.

*Type locality:* Lower part of the valley of the Rio Grande, and in the province of Tamaulipas, Mexico.

*Diagnosis:* A small, greenish, flat-headed *Bufo* without cranial crests (or very narrow ones closely approximated to the orbits); parotids large, elongate, broad.

*Comparisons:* The absence of cranial crests, or the presence of very narrow ones closely approximated to orbits, coupled with the broad, elongate parotid glands and greenish coloration is very distinctive of this Kansas toad. Of those within this state, *Bufo punctatus* most closely resembles it, but the round parotids, and the absence of numerous dark and light spots above characterizes it.

*Description:* Head very flat, outline from above distinctly pointed, the sides straight, eyes included; lores vertical; cranial crests consisting of a narrow ridge about and closely approximating eyes, in contact with tympanum in postorbital region; canthus rostralis a broad ridge extending from eye to

between nares, becoming progressively narrower; a narrow ridge in front of eye, and another below eye extending posteriorly nearly to angle of jaws and anteriorly to between nares and preorbital ridge; tympanum very small, the parotids encroaching upon them from behind, oval in shape; the dorso-ventral diameter greatest, less than internarial space; snout pointed in lateral profile, projecting considerably beyond the lower jaw; edge of upper jaw ridged; tongue small, oval; inner nares very large, their margins more closely approximated than the outer nares; orbits large, almost  $\frac{1}{2}$  the length of head, equal to distance from their anterior borders to tip of snout; interorbital space greater than diameter of orbits; parotids large, almost as long as head, and broader than internarial space; separated by a short distance from post-orbital ridge, a broad ridge passing between them directly above tympanum; angle of jaws directly below anterior edge of tympanum; fore limbs short, not enclosed in skin of body; fingers 2-3-5-4 in order of increasing length, toes 1-2-5-3-4; a large smooth metacarpal tubercle, bordered on side of "thumb" by a much smaller one; palmar surfaces of hand and foot rugose as body, subarticular tubercles slightly larger; fingers not webbed, toes about half-webbed, the three distal digits of the fourth toe free, the last of all the others; whole of dorsal surfaces rugose, the warts on body and hind limb largest, smaller on forelimb, parotids and head; tip of snout rugose, lores smooth; ventral surfaces granular.

Ground color above greenish, some of the warts yellowish, others blackish, the latter color frequently extending over several warts, but usually narrow, so that one obtains a reticulated instead of a spotted impression; hind legs faintly banded; ventral surfaces yellowish, belly sometimes spotted.

TABLE 14.

	Measurements of adults										
	1	2	3	4	5	6	7	8	9	10	11
Length of body	34.5	32.0	26.8	32.8	31.3	32.0	28.0	24.6	27.7	27.9	25.9
Width of head	12.0	10.8	9.5	11.5	11.7	11.2	9.8	9.5	10.1	10.0	10.0
Interorbital space	3.8	3.4	2.8	3.3	3.5	3.9	3.1	3.6	3.6	3.5	3.2
Fore leg	16.8	17.5	14.0	18.7	16.0	16.2	15.0	16.2	14.0	15.7	14.0
Femur	10.0	10.2	9.0	12.0	10.8	10.5	8.6	8.4	13.0	10.0	9.0
Tibia	10.8	11.3	9.3	11.8	9.8	10.9	8.9	9.2	9.0	9.5	8.8
Tarsus	4.8	5.0	4.0	5.3	4.5	5.8	4.0	4.7	5.0	5.5	4.8
Whole foot	16.0	15.1	14.0	15.5	15.0	16.2	12.3	12.4	13.0	13.9	13.7
Length of parotids	7.0	7.1	5.1	7.1	7.1	7.8	6.0	5.7	6.0	7.0	5.5
Width of parotids	3.5	2.9	2.1	3.5	3.9	4.0	4.0	2.8	2.9	3.5	3.0
Dist. between parotids	6.0	6.7	5.6	6.0	6.3	6.9	5.4	5.6	6.0	6.0	5.6

Nos. 1-3 are from Walsh Ranch, 18 mi. N. of Elkhart, Morton county; 4 is from Grant county; 5-7 are from Morton county; 8-11 are from Logan county.

*Larvae:* No detailed description has been given. Strecker (1926a) states that their larvae are smaller than those of *punctatus*, and that "their metamorphosis is accomplished within a very short space of time"—20 days or so.

A series of *Bufo* larvae, apparently undescribed, were collected September 6, 1933, in small pools at the rocky bottom of a small, nearly vertical-sided tributary of Schwartz Canyon, near Indian River in Comanche county, Kansas, in which region *debilis* is known to exist. It is impossible to state

front of jaws and small, the so-ventral al profile, w ridged; closely ap of head, ital space head, and ost-orbital angle of , not en- gth, toes "thumb" as body, out half- he others; b largest, smooth:

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10.0 10.0  
3.5 3.2  
15.7 14.0  
10.0 9.0  
9.5 8.8  
5.5 4.8  
13.9 13.7  
7.0 5.5  
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definitely at present what species these larvae represent, but I would suggest *debilis*. Their description follows:

Labial teeth 2/3, outer margins about even; outer row in upper labium not divided, second row sometimes divided, but never distinctly, the lateral halves but slightly separated if at all; rows of teeth in lower labium not divided, or nearly uniform length, the outer somewhat shorter than the others; upper mandible less than half the length of the adjacent rows of labial teeth; lower mandible sharply bent medially, forming an angle of about 100-105°; labial papillae confined to sides, the length of the lower part of one side about 1/6 the circumference of the lower labium; length of the upper part of one side about 1/8 to 1/9 the circumference of the upper labium; orbitonarial distance about half the distance between nares and snout, interorbital distance slightly greater than internarial; diameter of orbits about 1/5 greater than orbitonarial distance; spiracle sinistral, below lateral axis of body; anus median; tail 1/3 longer than head and body; tail musculature at base about 1/2 total diameter of tail at base; insertion of caudal fin about 1/3 the distance between insertion of hind legs and spiracle; total diameter of tail (dorso-ventral) nearly uniform throughout, slightly tapering toward distal end, broadest in middle; tip of tail rounded.

Dorsal surface of body uniformly stippled with black; ventral surface of body same, except for a broad median, sharply-defined, transparent 'stripe' from anus to between mouth disk and spiracle, very conspicuous in life; ventral caudal fin practically uniformly transparent, dorsal caudal fin with scattered, irregularly outlined, comparatively large, spots of pigment; tail musculature stippled as body.

Eggs: Strecker (*op. cit.*) remarks that they are laid in "small strings and are attached to grass and weed-stems."

Song: Cope (1893) states that "When in water, its cry is like that of *Bufo lentiginosus americanus*, but is more feeble, and very 'nasal'." Strecker (1908) remarks that "after a heavy rain their presence can soon be detected by their peculiar, long-drawn, bird-like notes."

Breeding habits: In Texas "It breeds abundantly in April and May in rain-formed pools and ditches." (Strecker, 1915) In Kansas Taylor (1929) heard them singing as late as August 8. Actual breeding may be delayed until as late as June 27, as some females, with eggs, were captured by Dr. Taylor in Texas at that time.

Habits and habitat: Taylor (1929) has recorded the following concerning Kansas specimens:

I found this small toad after a heavy hail and rainstorm August 8, 1926. While collecting late at night the thin, feeble piping was heard more than half a mile away. After a long search two specimens were found in icy water in a small temporary pool into which much hail had washed. Several dead specimens killed by hail were found at a large temporary lake six miles north of the river. In 1928, Albert Lunceford, Jr., discovered specimens under rocks in the bluffs north of the river.

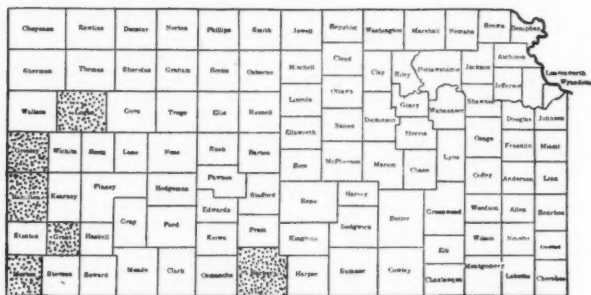
Strecker (1926) states that

*Bufo debilis* Girard is smaller than the spotted toad [*Bufo punctatus*] and is even more retiring in habits. Like *Scaphiopus couchii* Baird and *Bufo compactilis*

Weigmann, it is possible to obtain this species in quantity only a few days in each year, when they are in their breeding pools or have been driven from their burrows by heavy rains. *Bufo debilis* is a toad of the mesquite timber prairie and with the aid of a flashlight an occasional specimen may be found in such environments even on a dry summer night, but the collector may be literally compelled to walk miles in an effort to find such scattering examples. Like *punctatus* they move around only after darkness has set in.

Cope (1893) found it frequently "in the grass, where its green color aids in concealing it."

*Distribution:* Western Kansas south to Texas and northern Mexico, west to western Colorado and New Mexico.



Map 11. Distribution of *Bufo debilis* Girard.

KANSAS—BARBER COUNTY: (Cragin, 1884). GRANT COUNTY: (KU 5642; Kellogg (1932b). GREELEY COUNTY: 9 mi. NE of Tribune (KU, 1 spec.). HAMILTON COUNTY: (Cragin, 1884). LOGAN COUNTY: (KSC 50-55). MORTON COUNTY: (Cragin, 1884; Kellogg, 1932b; Elkhart, 18 mi. N. of (Taylor, 1929; Hill, 1931; KU 5643-50).

*History:* Cragin reported *debilis* from Kansas in 1894, in Barber, Hamilton and Morton counties. Taylor (1929) reported them again in Morton county, and Hill (1931) also. Kellogg (1932) mentions them from Morton and Grant counties.

*Remarks:* *Bufo punctatus* is generally considered to be rather erratic in its distribution, but *debilis* is quite as much so. Reports have been obtained from central Texas, central and northern Mexico, southern parts of New Mexico, Colorado, and southwestern Kansas.

### *Bufo punctatus* Baird and Girard

#### SPOTTED TOAD

*Bufo punctatus* Baird and Girard (1854, p. 173).

Cope (1889, pp. 262-264, fig. 60).

Storer (1925, pp. 192-199, text fig. JJ). A complete description and discussion of habits and life history.

Strecker (1926b, pp. 8-10). Notes on habits.

Slevin (1928, pp. 100-102). A synonymy complete to date.

Hill (1931, pp. 547-548). The first and only report from Kansas.

*Type locality:* Rio San Pedro of the Rio Grande del Norte.

*Diagnosis:* A *Bufo* without or with very inconspicuous cranial crests; parotids round, in contact with a slight postorbital ridge and with tympanum; warts numerous, low and reddish; size small (75mm. or less).

*Comparisons:* The only other Kansas toad not having, or with very inconspicuous, cranial crests, is *Bufo debilis*, which differs from *punctatus* by having elongate parotid glands and a general greenish coloration.

*Description:* Head flat, somewhat pointed in dorsal profile, snout truncate in lateral profile; eye comparatively large, diameter equal to distance between it and end of snout; tympanum small, oval, the dorsoventral diameter greatest and about equal to distance between nares; interorbital crest absent or inconspicuous, closely bordering orbits when present; postorbital ridge absent or inconspicuous, more constant at point of contact with parotid glands, from which point a branch proceeds along anterior edge of tympanum; interorbital distance about equal to or a little less than diameter of orbit; canthi rostrales broad, inconspicuous ridges; lores nearly vertical, smooth; head very spinose—more so than body, especially about orbits and about edges of upper jaw; tongue elongate, small, anterior two-thirds attached; internal nares large, situated far anteriorly, about twice as far apart as external nares; anterior limbs long, not enclosed in skin of body; fingers 3-2-5-4 in order of increasing length, toes 1-2-5-3-4; a large median palmar tubercle on hand, closely approximated on side of second digit by a much smaller one; tibio-tarsal articulations touching as limbs are flexed and femora held at right angles to body; a small inner and a somewhat smaller outer metatarsal tubercle present; fingers not webbed; toes about half-webbed.

Color brownish or gray above, the warts more reddish and the cephalic region more dark-reddish; ventral surfaces yellowish, with small blackish spots; larger dorsal warts edged with black.

*Sexual dimorphism:* Males possess dark vocal sacs and are somewhat smaller than females. Storer (1925, p. 195) states that they are darker in color than females, and their parotids are slightly higher.

TABLE 15.

## Measurements of adults

	1	2		1	2
Length of body	53.6	31.0	Tibia	21.5	12.3
Orbit	6.0	3.5	Tarsus	11.5	7.0
Interorbital space	6.0	3.65	Whole foot	30.0	17.2
Fore leg	31.5	17.3	Length of parotids	6.0	4.0
Femur	21.0	12.0	Width of parotids	7.0	4.3
			Space between parotids	11.0	6.5

No. 1, KU 9100, 12 mi. N. of Elkhart, Morton county; No. 2, Comanche county.

*Description of larvae:*

Greatest length of head-and-body 10.6 mm.; of tail 15.4 mm.; length of head-and-body contained 1.4 times in length of tail; width of body in head-and-body length about 1.9; nares about equidistant from orbit and tip of snout; internarial width about 1.3 in interorbital width; interorbital distance 4 to 7 in head and body length; eyes about 30 per cent of head-and-body length from tip of snout; spiraculum sinistral and lateral, aperture directed backward and slightly upward, center



of aperture posterior to mid-point of head-and-body; anus median; tail musculature moderate, height of muscular portion at base about 5 in length of tail.

Labial teeth in 2-3 row; first row complete, second divided, lower-most row shorter than two preceding; labial papillae only at sides of mouth region. (Storer, 1925, p. 194).

*Eggs:* Strecker (1926b) mentions them, stating that they are laid in strings, some of which "were attached to plant stalks, while others were freely floating among dead leaves or in the shallows." Wright (1929) adds, somewhat differently, that "eggs single or firm or scattered mass on bottom, not in files."

*Song:* (Strecker (1926b) states that the notes are "clear, bird-like whistles, repeated at intervals. When handled, the male emits a chirp which sounds much like that of a young bird." Storer (1925, p. 197) states that it "is described as 'a long continued clear trill, resembling that of a hearth cricket but with more volume' (Grinnell, MS)."

*Breeding habits:* Breeding apparently takes place in late April and early May. Enghardt (1917) reports having seen their larvae on June 6-10, 1916, and Camp (1916) observed larvae and recently metamorphosed young, presumably of this species, on May 28, 1914.

*Habits and habitat:* "In captivity these toads make small burrows in moss or soft earth, and sit patiently hour after hour with just the bright eyes showing at the doors of their burrows." (Dickerson, 1913).

Normally these toads are desert-living, although they apparently are successful in regions of irrigation, and in central Mexico they exist on high plateaus. Ellis and Henderson (1915) report them at an elevation of 6,500 feet, while Stejneger (1893) reported the form from Death Valley. The specimen from Comanche county, Kansas, was collected in broad daylight at about 10 o'clock on September 6, 1933, basking on the ground amongst boulders in the more or less feeble rays which penetrated the foliage of nearby trees.

Movement apparently takes place only under cover of darkness, stones and under-ground niches serving to conceal them during the day.

The moisture requirement is, according to Storer (1925) very low:

Ecologically, *punctatus* is restricted to desert canyons containing seepage or springs. Its present wide general distribution was probably accomplished at some time in the past, when less arid conditions prevailed on the southwestern deserts. . . . Practically all of the other Salientians which occur in the American southwest are restricted to the vicinity of the larger streams and they can continue there as long as these mountain streams persist.

Further details on habits are given by Storer (1925), and Strecker (1926b).

*Food:* Terrestrial forms would logically comprise the main portion of the food of this toad, so markedly emancipated from the usual bonds of aquatic life. Tanner (1931) found that beetles, bugs, ants and bees were present in their stomachs—ants being the most predominant form of all.

*Distribution:* From southeastern California and Cape San Lucas, Lower California, east to the western parts of Texas, Oklahoma and Kansas, north to the southern parts of Colorado and Utah.

Map 12. Distribution of *Bufo punctatus* Baird and Girard.

KANSAS—COMANCHE COUNTY: Schwartz Canyon, on Indian River, near Arrington (KU, 1 spec.). MORTON COUNTY: 12 mi. N. of Elkhart (Hill, 1931; KU 9100).

Remarks: Comanche county, Oklahoma, is the nearest locality to Kansas from which this toad has been reported (Ortenburger, 1926). Apparently the nearest records other than this are those from extreme southwestern Colorado (Ellis and Henderson, 1915; Burnett, 1924) and southern New Mexico (Van Denburgh, 1924).

*Bufo woodhousii woodhousii* (Girard)

ROCKY MOUNTAIN TOAD

*Bufo woodhousii* Girard (1856, p. 86).

Pack (1922b, pp. 46-47). Mentioned as of value in regulating outbreaks of insects.

Dice (1923, pp. 45, 53). Recorded from the Valley Forest community and Edificarian community of Riley county.

Force (1925, p. 26). Food.

Storer (1925, pp. 199-203). A full description and general account.

Burt (1927, p. 3). Recorded from Riley county.

Slevin (1928, pp. 102-105). Description and more or less complete synonymy.

Burt and Burt (1929a, p. 13). Recorded from Marion county and Riley county.

Burt and Burt (1929b, p. 430). Recorded from Marshall, Washington and Stafford counties.

Taylor (1929, p. 65). Recorded from Morton county. Habits.

Force (1930, p. 26). Eggs and transforming tadpoles collected in Tulsa county, Oklahoma, on March 25, 1929.

Tanner (1931, pp. 183-183). Description, habits, food.

Burt (1932, pp. 78-79). Recorded from Marshall county. Habits.

Kellogg (1932b, pp. 72-74). Mentioned from Doniphan county.

*Bufo americanus* (nec Holbrook) Hallowell (1857a, p. 251). Mentions two specimens in the collection from Kansas and Nebraska, without definite locality records. Although I have not seen these toads, it is probably from the description of them that Hallowell had *woodhousii woodhousii* before him.

Ellis and Henderson (1913, pp. 55).

*Bufo punctatus* (nec Baird and Girard) Hallowell (1857, pp. 309-310). Considers *B. punctatus* the young of *Bufo americanus*. Recorded from Ft. Riley, Geary county.

*Bufo lentiginosus* Shaw, var. *fowlerii* (part.) Cragin (1881, p. 119).

*Bufo lentiginosus* Shaw., var. *americanus* (nec Holbrook) Cragin (1881, p. 119).

Said to be common at Manhattan and westward. The only toad of this group near Manhattan is *woodhousei woodhousei*.

Yarrow (part.) (1883, pp. 166-167). Little Blue River and Ft. Riley.

Cope (part.) (1889, pp. 284-289, fig. 270). Same localities as given by Yarrow.

Hartman (part.) (1906, pp. 227-228). Food. Recorded from Graham county.

*Bufo lentiginosus frontosus* Cragin (1881, p. 119).

Yarrow (1883, p. 165). Kansas.

*Bufo lentiginosus woodhousei* Cope (1889, pp. 281-284, fig. 69). "Kansas."

*Bufo woodhousei* Ellis and Henderson (1913, pp. 54-55).

Linsdale (1927, pp. 75-76). Recorded from Doniphan county. Habits.

Type locality: San Francisco Mountain, Arizona.

**Diagnosis:** A *Bufo* with well-developed cranial crests which do not possess conspicuous tympanic or preocular branches, usually parallel or slightly divergent; the area between swollen until practically level; parotid glands present, widely separated and elongate, not swollen laterally; tympanum distinct, vertical diameter usually greater than internarial distance; dorsal tubercles numerous, rather small, usually not spinose; a few or sometimes numerous dorsal spots, usually small, occasionally including several warts; profile of snout truncate in both sexes; ventral surfaces immaculate; size, large.

**Comparisons:** The distinct parotid glands and cranial crests, coupled with the color pattern, distinguish this toad from all others in Kansas except the American toad (*Bufo americanus*). From this it differs as follows:

*americanus*

1. Warts on body larger, less numerous.
2. Usually but one or two warts to a dark color spot.
3. Skin on median anterior surface of tarsi and metatarsi with blackish spines.
4. Parotids broad and closely approximated, not separated by more than their own length.
5. Cranial crests never swollen to form a "plateau."
6. Snouts of males in lateral profile pointed to some extent.
7. Belly usually profusely spotted.
8. Song a high trill of long duration—20-30 seconds or so.
9. Eggs laid single file, enclosed in a double tubular membrane, with a partition between each egg.
10. A median dorsal light line rarely present; when present, very irregular.
11. Parotids usually separated from postorbital ridge, the latter, either directly or by a secondary arm, in contact with the tympanum.
12. Second subarticular tubercle of fourth toe frequently divided; first but seldom not divided.

*w. woodhousei*

1. Warts on body smaller, more numerous.
2. Some of dorsal spots including many warts (eastern specimens) or but one or two (western specimens).
3. Skin on median anterior surface of tarsi and metatarsi without blackish spines.
4. Parotids narrow, although not so long, and separated frequently by more than their own length.
5. Cranial crests frequently swollen, forming a "plateau."
6. Snouts of both males and females sharply truncate in lateral profile.
7. Belly usually immaculate or with a single median dark breast spot.
8. Song a low trill of 3-4 seconds or so.
9. No partitions between eggs; but a single tubular membrane.
10. A median dorsal light line always present.
11. Parotids usually in contact with the postorbital ridge, the tympanum separated distinctly from the latter and tympanum.
12. Second subarticular tubercle apparently never divided; first but seldom.

*Description* (from live material): Head thick, short; snout rounded or truncate in lateral profile, protruding beyond lower jaw but not pointed as in *americanus* (at least in the males of the latter); angle of lores about 45 degrees; outline of head from above usually slightly pointed, the eyes protruding slightly beyond the outline; angle of jaws about directly below tympanum (middle of); latter oval, the vertical diameter greatest, and equal to or less than distance between outer edges of the nares; longitudinal diameter about equal to the distance between the inner edges of nares; latter somewhat greater than distance between anterior edges of orbits and nares; longitudinal diameter of orbit slightly more than, and vertical diameter about equal to, the vertical diameter of tympanum; distance between cranial crests about equal to internarial distance, frequently greater behind; postorbital crests present, reaching to lateral edge of parotid gland, which is usually in contact with it, but not to the tympanum; latter separated from parotid gland by about 1/3 its longitudinal diameter; parotids long and narrow, separated by about their own length, or more; parotids usually about as long as head, and about as wide as internarial distance; upper portion of lower eyelid, except a narrow border, transparent, the lower portion translucent or opaque; jaws without teeth; tongue ovoid, without papillae or plicae; dorsal warts small, but frequently extremely numerous, all usually spinose; no greatly enlarged warts on either side of median line, as frequently in *americanus*; frequently a series of lateral light-colored spines, and a group above axilla; warts on dorsal surfaces of hind limbs not conspicuously enlarged; ventral surfaces granular, but not spinose, the spines, if present, very minute; some larger granules in pectoral region; no enlarged, brightly colored tubercles above anus; one or two series of spinose papillae on the posterior surfaces of forearm; fingers not webbed, 3-5-2-4 in order of increasing length, toes 1-2-5-3-4; a large flat outer metacarpal tubercle and a small inner; palmar and subarticular tubercles present, not divided; toes about 2/3 webbed; a large, blackened inner metatarsal tubercle, with a free outer cutting edge; a small blackened outer metatarsal tubercle; subarticular tubercles present, the second sometimes divided, usually single.

Color usually gray to yellow above; spots on body blackish or greenish, sometimes small and including but one or two warts, but frequently large and including many warts, as in *fowleri*; a narrow median light line practically always present, as well as a lateral light line from below the parotid glands to the inguinal region; usually a transverse bar above each orbit; upper labial region with about three cross-bands; large dorsal cross-bands present on femora, tibiae and tarsi; fore limbs frequently with a few similar bands; ventral surfaces usually immaculate, or with a single median breast spot, rarely with a few other scattered spots on breast; ventral surfaces whitish to cream-colored; light areas of posterior surfaces of femora and inguinal region strongly yellowish.

*Sexual dimorphism*: In adult males the vocal sac is blackish and the second and third fingers are enlarged and with corneous tissue which aids in clasping the female; the skin is usually somewhat less rugose; size considerably smaller; tips of toes and fingers more corneous than in females.

TABLE 16.

Measurements of Adults											
	1	2	3	4	5	6	7	8	9	10	11
Body length	94.2	100.8	76.2	86.0	88.0	93.8	118.0	99.5	77.8	101.5	88.8
Head width	41.0	43.0	34.6	34.4	38.2	37.6	42.6	42.6	33.3	42.6	32.4
Interor. space	8.2	8.7	6.8	6.6	8.4	8.4	9.5	9.1	7.0	8.4	6.8
Fore leg	59.0	59.0	45.1	47.0	57.5	51.5	63.5	63.0	44.0	55.0	56.0
Femur	39.0	36.0	28.5	30.0	33.5	34.0	39.0	39.0	30.0	39.0	37.0
Tibia	32.5	37.0	25.4	30.5	31.0	33.5	37.7	38.0	28.0	34.7	13.1
Tarsus	19.5	17.0	15.0	13.0	16.5	16.0	18.0	19.0	15.0	17.0	18.0
Whole foot	55.0	46.0	45.0	45.6	50.0	51.5	57.0	55.0	43.0	56.2	50.0
Parotids, length	14.7	18.2	13.2	16.8	16.5	15.1	19.0	17.9	13.2	18.0	16.0
Parotids, width	5.9	9.2	7.2	8.1	5.2	7.0	9.0	9.0	6.9	9.1	7.1
Parotids, sp. betw.	17.0	19.2	16.0	17.1	16.1	19.0	22.0	19.0	16.2	19.2	17.6
Head length	24.2	26.5	20.3	23.5	16.9	20.7	30.0	25.2	19.3	27.8	20.8
Sex	fem. male			fem. fem.			fem.	fem.	fem. male	fem. male	

No. 1, 18 mi. N. of Elkhart, Morton county; no. 2-3, Arkansas City, Cowley county; no. 4, Pendennis, Lane county; no. 5, Mt. Oread, Douglas county; no. 6, Doniphan Lake, Doniphan county; no. 7, Mt. Oread, Lawrence, Douglas county; no. 8, Haskell Meadows, Douglas county; nos. 9-11, Arkansas City, Cowley county.

*Larvae:* Unknown.

*Eggs:* The eggs of *woodhousii woodhousii*, as laid in the laboratory, very closely resemble those of *fowleri*. The inner membrane is absent, there being but a single tube, about 3.5 mm. in diameter. The egg complement of a single female which laid in captivity was 25,644 by actual count. The arrangement of the eggs within the tube varied from a very closely crowded condition to a single row.

*Life history:* *Woodhousii* has been heard singing as early as April 28 near Lawrence, and Gloyd (personal notes) has heard them as late as July 15 in the vicinity of Riley county. Observations made near Lawrence indicate that it breeds later than *americanus*, as *fowleri* does in the east. The life history of the latter has been observed in more detail. Wright & Wright (1924) state that it breeds from April 15 to August 17, or, in given localities, from 2-6 weeks later than *americanus*. Force (1930) has recorded the eggs of *woodhousii* considerably earlier than this (March 25). Young and recently transformed toads have been recorded by Linsdale (1927) as early as July 6.

Amplexation is axillary.

*Song:* A short, low trill of about 3-4 seconds duration.

*Habits:* Taylor (1929) reports that "Very large adults were found in the prairie dog-villages at night. They hide in holes during the day." Their tendencies to remain about human habitations have been noticed by several authors (Hartman, 1906; Dice, 1923; Linsdale, 1927). Dice (1923), in speaking of communities of vertebrates of Riley county, Kansas, further records *woodhousii* from the valley forest community, a description of which he gives.

Burt (personal notes) states:

It has been said that this toad may visit beehives upon occasion to "fill up on bees," so at least one southern Kansas beekeeper transports it away from his apiary whenever possible.

Ruthven (1907), discussing habitat relations of this toad near Alamogordo, New Mexico, says that:

All of the specimens of this toad were taken in the evening along the irrigation ditches in the Mesquite association on the plains. As in the case of *B. punctatus*, the natural habitat of *var. woodhousii* is probably the canyons in the mountains, where moisture is more abundant, and it can be considered to have extended its range out onto the plains with the advent of irrigation ditches. Nothing seems to have been recorded as to the habits of this toad. As in the case of *Bufo americanus*, beetles make up the bulk of the food, as is shown by an examination of stomach contents. Another important article of food is the grasshopper. Doubtless spiders and caterpillars also form a part of the food as in the case of the eastern form.

During the intense heat of the day these toads were not seen, but at about dusk they came out in numbers along the shallow ditches, especially near street lamps.

Apparently it is customary for the toads to remain concealed during the day in the west, being practically entirely nocturnal or crepuscular. However, Burt (1932) has shown that in the eastern part of its range the toads search for food early in the morning, having been concealed during at least the latter part of the night. His remarks are of interest:

This species is common in favorable habitats in the middle west, even in the open prairie regions where trees are few or absent. At about seven o'clock on the cloudless morning of August 18, the sun was rapidly warming numerous exposed sand banks near Antioch, Nebraska. Here, many distinct trails involving the two rather widely separated and far spaced elements of various pairs of tracks were noted on the surface of the sand, each trail leading to a tiny mound, where it ended. Digging revealed the fact that each of these shallow mounds held a practically grown toad. Thus several dozens were collected in a short time, both here and at other points. By eight o'clock most of the toads had left their respective holes in the sand. Although some were found hopping about, it was much harder to secure a series of the creatures after this hour. It is probable that after leaving its temporary larval home in shallow lakes and pools, the young sandhill toad migrates to the hillsides where it burrows into the sand at night and becomes inactive as the earth is cooled. In the morning it apparently awakes after the sand has been re-warmed by the sun, crawls to the edge of its temporary shelter, shakes itself, absorbs warmth producing energy, and then engages in a short diurnal pursuit of the insects upon which it preys. It would be of interest to learn just what the half grown sandhill toad does during the late forenoon and afternoon of the day, and also its behavior when it enters its sandy bed at night. Since individuals occurred in sand banks which were a significant distance away from the then existing bodies of water, it seems not improbably that these toads may remain permanently away from open water after they have emerged from it. This may be on account of some practical morphological or physiological adaptation which prevents rapid bodily loss of moisture.

It is possible that these habits mentioned by Burt are adapted to the particular environment in which the toads were observed. That it is customary for them to emerge in late evening and to remain active for some time at night, and quiescent during the day, is well known. Also, that they would seek protection in the very early morning, as the temperatures continue to decrease, might be expected. That there should be a period of activity shortly after sunrise, however, is interesting. It is possible that, once emerged in morning, they would continue the search for food providing the day were sufficiently cloudy.

Near Lawrence this toad is the most ubiquitous of all the toads or frogs, occurring in almost every conceivable habitat. The American toad (*Bufo*



*americanus americanus*), which also exists in this region, is more restricted in its ecological distribution, being apparently confined to certain semi-permanent pools of water about which they are numerous during the breeding season. They do not occur about dwellings, along the rivers, and in other habitats frequented by *woodhousii*.

**Food:** Tanner (1931) recorded the stomach contents of several specimens of *w. woodhousii*, and found that beetles compose the greater portion of the diet, with considerable quantities of insect larvae added. The remainder consisted of smaller numbers of insects, arachnids and oniscids.

Force (1925) found that "Of the food content of 21 specimens of *Bufo woodhousii*, 47% was found to be Formicidae, 19% Meloidae, 13% Carabidae, 12% Scarabaeidae, 1% Calandridae, 6.5% Dytiscidae, 4% each Cucujidae and Myrmecidae, 2% Elateridae, and less than 1% each of Coccinellidae, Cicindelidae, Staphylinidae and larva."

The importance of this and other toads in the regulation of insect pests is discussed by Pack (1922b):

The importance of toads in assisting to check insect outbreaks was remarkably illustrated in Cache county, Utah, last August. The third brood of the sugar-beet webworm developed such proportions in the Benson district that many fields of beets were partly or wholly destroyed. As the webworms increased in number and size, however, natural enemies were attracted. . . Among these enemies were astonishing numbers of our common toad, *Bufo woodhousii* Girard. Most of the toads were of this year's brood, ranging in length from one and a fourth to one and a half inches. I would estimate that in one field of about one square acres there were no fewer than one-hundred toads.

An examination of the stomach contents of a number of toads disclosed the fact that they were feeding exclusively upon the webworms and that every one was gorged to the limit. These small toads contained from 24 to 40 worms each, the limiting factor in quantity being the size of the stomach. A number of representative toads were weighed, and the stomach contents of each were then removed and weighed. It was found that the weighed food represented 16 percent of the total weight of the toad. If the toad fills its stomach four times every four hours, as Kirtland<sup>1</sup> maintains, these toads were daily eating a mass of webworms two-thirds their own weight!

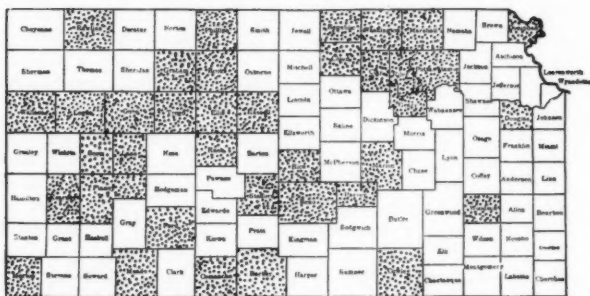
**Distribution:** Western United States east of the Sierra Nevadas and Cascade Range, east to western Texas, Oklahoma, Kansas and Nebraska.

KANSAS: Probably over the entire state. Actual records are as follows:

BARBER COUNTY: Sun City, 5 mi. S. of (KU 6090). CLAY COUNTY: Clay Center (UMMZ 66862-66863); Aetna (KU, 2 spec.). CLOUD COUNTY: Miltonvale (UMMZ 66860-66861). COMANCHE COUNTY: 3-4 mi. SW of Arrington (KU, 3 spec.). COWLEY COUNTY: Arkansas City (KU 6106-6119, 14344-14385); Winfield, 7 mi. SE of (HMS, 1 spec.); Winfield, Southwestern College Campus (USNM). DONIPHAN COUNTY: Doniphan Lake (Linsdale, 1927; Kellogg, 1932b; KU 6369-6376, 6384-6394). DOUGLAS COUNTY: (KU 6338, 6343-6345, 6362-6363, 6386, 6389, 6392, 9393, 6396, 6397, 6564-6566). ELLIS COUNTY: (L. A. Brennan, MS). FINNEY COUNTY: Garden City (KU 6086). FORD COUNTY: (OU 160-164). GEARY COUNTY: Fort Riley (Hallowell, 1857b; USNM 4543); Junction City (KU 6087). GOVE COUNTY: (USNM 57478-57479; KU 6093-6094). GRAHAM COUNTY: (Hartman, 1906). HARVEY COUNTY: Halstead, 10 mi. NW of (USNM 88793). KEARNEY COUNTY: Deerfield, 1 mi. E of (CEB). LANE COUNTY: Pendennis (KU 6095-

<sup>1</sup> U. S. Dept. Agr. Farmers' Bull. 196, p. 13.

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Map 13. Distribution of *Bufo woodhousii woodhousii* (Girard).

6105). LOGAN COUNTY: Elkader (KU 6091-6092). MARION COUNTY: Lost Springs 2 mi. S. of (Burt and Burt, 1929a). MARSHALL COUNTY: (USNM 87163); Blue Rapids (Burt and Burt, 1929b; KU 6398-6401); Blue Rapids, 4 mi. N. of (Burt, 1932). MEADE COUNTY: 35 mi. SE of State Park (KU, 2 spec.). MORTON COUNTY: (Taylor, 1929); Elkhart, 18 mi. N. of (KU 5940-6036, 6050-6059, 14389-14423). PHILLIPS COUNTY: Phillipsburg, 6 mi. W and 1/4 mi. N of (KU 15190). POTTAWATOMIE COUNTY: (USNM, 13 spec.). RAWLINS COUNTY: Atwood, 27 mi. W of (KU 6395). REPUBLIC COUNTY: Munden (UMMZ 66854). RENO COUNTY: Medora (USNM, 4 spec.). RICE COUNTY: (KU, 1 spec.). RILEY COUNTY: (Dice, 1923; Burt, 1927; UMMZ 66855-66859; MVZ, 8 spec.; KSC 32-34); Manhattan (Cragin, 1881; USNM 88950-88957); Cleburne, 2 mi. N. of (Burt and Burt, 1929a); Randolph, 7 mi. N. of (Burt and Burt, 1929a). ROOKS COUNTY: (KSC 24-26, 38-40). RUSH COUNTY: McKenna (KU 6088). RUSSELL COUNTY: (USNM 51621; KU 6089, 14257-14280). SCOTT COUNTY: near State Lake (KU, 1 spec.). STAFFORD COUNTY: St. John (KSC 18-19); Little Salt Marsh (KU 6037-6038, 6039-6048; 6060-6061); SW corner of county (KU 5927); Big Salt Marsh (Burt and Burt, 1927b). TREGO COUNTY: (KU 6076-6080); Collyer, 12 mi. S. of (KU 6066, 6068-6070, 6071-6075, 15605-15606); Banner (KU 6076-6080). WALLACE COUNTY: (KSC 20-23, 35-36); Rhino Hill Quarry (KU 15608-15611). WASHINGTON COUNTY: Haddam, 5 mi. N of (Burt and Burt, 1929b); Haddam, 3 mi. NE of (Burt and Burt, 1929b). WOODSON COUNTY: Neosho Falls (KU 14241).

**History:** The first indication that *B. w. woodhousii* existed in Kansas was given by Hallowell, in 1857 (a), who ascribes two specimens to *americanus*. Although I have not seen his material, the recent interpretation of the toads existing in Nebraska and Kansas, together with his description, indicate that in reality his toads were *woodhousii*. No definite localities were given. The same author, however, in an "appendix" to an article preceded by the former by less than a hundred pages, mentions a few specimens of "*Bufo punctatus*," which he considers to be no more than the young of *Bufo americanus*, from Ft. Riley, Geary county. That he had before him nothing more than *woodhousii* is practically certain. This record, however vague, is the first authentic one for Kansas. The next information regarding the toad is given by Cragin (1881), who recognizes 4 species of toads within the state: *Bufo lentiginosus fowleri* (a name preceding the type description one year, probably derived from Cope's check-list of 1875), *Bufo l. americanus*, *B. l. cognatus* and *B. l. fowleri*. The first of these no doubt refers largely to *americanus* as now

known, although evidently some *woodhousii* were confused, as the former has never been found so far west as Manhattan, contrary to Cragin's statement. His *B. l. americanus* can be none other than *woodhousii*. *B. l. frontosus* is an exact synonym of *woodhousii*. Cragin, thus, actually reported but two species: *cognatus* and *w. woodhousii*. The only definite locality given for the latter is Manhattan. Yarrow, in 1883, records *frontosus* (an exact synonym of *woodhousii*) from "Kansas," and *Bufo lentiginosus americanus* from Little Blue River and Ft. Riley. *Woodhousii* must have been his toad in both cases. Aside from acknowledging the synonymy of *frontosus* in *woodhousii*, Cope's records and remarks of 1889 are the same given by Yarrow. A number of years later Hartman (1906) reported having collected specimens (ascribed undoubtedly incorrectly to *Bufo lentiginosus americanus*) in Graham county. A number of years passed without further reports, until in 1923 Dice opened a period continuing to the present of a rapid succession of reports from various authors: Linsdale (1927); Burt (1927, 1932); Burt and Burt (1929a, b); Taylor (1929).

*Remarks:* As has been previously indicated, it is the opinion of the writer that the forms known at present as *Bufo woodhousii* and *B. fowleri* are in reality more closely related than the specific status of their names would indicate, or, that they are subspecies. That is, the eastern form should be known as *Bufo woodhousii fowleri* (Hinckley), and the western as *Bufo woodhousii woodhousii* Girard. That this was the probable relation of the forms was indicated by Strecker and Williams (1928).

In the paragraph above on comparisons, *woodhousii* was distinguished from *americanus*. It will be observed, however, that it differed in exactly the same manner in which *fowleri* differs, with one exception—according to Wright and Wright (1924), the egg complement is about 7,750. However, this difference between the egg complements of *fowleri* and *woodhousii* is no greater than that between the complement for *B. americanus* as given by the same authorities (4,000-8,000) and that found for the same species near Lawrence (about 20,000; 20,309 by actual count). The complement undoubtedly varies with the size of the female, and might be expected to be less in the east, where *fowleri* is never so large as *americanus*, than in the west, where *woodhousii* becomes larger than *americanus*.

The similarities between *fowleri* and *woodhousii* are striking. Their songs are practically identical; that of *fowleri* is perhaps a second or so shorter. The egg membranes are also practically identical, while the differences of either of these two species compared with *americanus*, with respect to song and egg membranes, is very striking. Further, the less spinose (than *americanus*) character of *fowleri* is just as truly a characteristic of *woodhousii* as of the other form. The tendency of the latter species to frequently form a "plateau" between interorbital crests is paralleled in *fowleri*. A median dorsal light stripe is also invariably present in each; the snout is truncate and not flared in each, so that the eyes form part of the outline of the head viewed from above. The cranial crests of both species tend to be parallel, although there is considerable erratic variation. The bellies of both are

usually immaculate or with a single median dark breast spot; the first sub-articular tubercle is occasionally divided, the second never, in both; the breeding season of the two species practically coincide, and is about 2-6 weeks after *americanus* begins.

Having cited similarities between *fowleri* and *woodhousii*, it is difficult to find differences which would justify even subspecific status.

Perhaps the difference in size is most important. Females attain a length of 120 mm., and males 90, in *woodhousii*, while Netting (1930) remarks that "The average head-body length (snout to vent) is 58.6 mm. for 89 male *fowleri*, 59.9 mm. for 55 female *fowleri* . . . The largest males of *fowleri* I have even seen are 65 mm. in length. A female *fowleri* from Missouri measures 78.5 mm. . . . Western specimens of *fowleri* average several millimeters longer than eastern specimens."

There are some differences in color pattern. It is rather seldom that *woodhousii* appears as brightly marked as *fowleri*, as all the dark markings are not so large and distinct. Usually there are a few such markings on all specimens of the western form, but the remainder of the markings are small, including from but 1-3 warts. However, the markings of *fowleri* are usually all, or at least the majority of them, large and elongate.

A third difference may be the complement of eggs, as Wright and Wright (1924) record 7,750 for *fowleri*, while the writer has obtained as many as 25,644 by actual count from a single female of *woodhousii*.

The area of intergradation can be stated only indefinitely at present. Presumably it includes parts of western Missouri, western Arkansas, eastern Oklahoma, eastern Kansas, and northeastern Texas. In eastern Kansas the gradation toward *fowleri* from the central part of the state is so gradual that I have been unwilling to ascribe any series to *fowleri* in spite of the strong tendency of a few specimens toward it. In no case has the majority of the specimens in a series from a single locality in the eastern part of the state been similar to *fowleri* and unlike *woodhousii*.

#### *Acris gryllus* (Le Conte)

##### CRICKET FROG

*Rana gryllus* Le Conte (1825, p. 282).

*Acris gryllus* Hallowell (1857a, p. 251). A record from "Kansas and Nebraska."

Hartman (1906, p. 228).

Burt (1927, p. 3). Recorded from Riley county.

Linsdale (1927, p. 76). Recorded from Doniphan county.

Gloyd (1928, p. 117). Recorded from Franklin county.

Burt and Burt (1929b, p. 431). Recorded from Clay, Franklin and Marshall and Washington counties.

Wright (1931, pp. 156-196). Complete discussion of life history, etc. Recorded from Emporia and Lawrence.

Burt (1932, pp. 80). Recorded from Cowley and Woodson counties.

Gloyd (1932, pp. 395-396). Recorded from Miami county.

*Acris gryllus*, var. *crepitans* (sic) Cragin (1881, p. 116). Recorded from 150 miles west of Ft. Riley. If this were accurate, the point would be in Ellis county. Also from Ft. Riley.

*Acris gryllus crepitans* Yarrow (1883, p. 169). Recorded from 105 miles W. of Ft. Riley, "Kansas" and Ft. Riley.

Cope (1889, pp. 326-330). Recorded from the same localities given by Yarrow (1883).

*Type locality: ?*

*Diagnosis:* A hylid, with intercalary cartilages and with minute terminal disks on digits; toes quite or nearly fully webbed, fingers not at all; head pointed; skin rugose to smooth; hind foot, excluding tarsi, over or equal to half the length of head and body; size small, not over 30-35 mm. in length.

*Comparisons:* The presence of intercalary cartilages, slightly dilated tips of digits, round pupils, absence of parotids and absence of dorso-lateral folds distinguish this from all other Kansas Salientia except the other hylids. From *Hyla* it differs in the possession of minute, not distinctly enlarged, terminal disks on the digits, and in the general Rana-like habitus. *Pseudacris* differs from it in the lack or minute size of the webs on the toes.

*Description:* Head rather sharply pointed and elliptical in dorsal profile, orbits within margin of profile; snout pointed in lateral profile, protruding somewhat beyond the lower jaw; internarial distance about equal to interorbital or somewhat greater; orbitonarial distance about equal to internarial distance, slightly less than orbital diameter; distance from nares to tip of snout variable, usually about equal to internarial distance or slightly less; nares somewhat elevated in lateral profile; tympanum indistinct, low, the dorsal margin frequently on a level with ventral margin of orbits; tympanum small, about half the internarial distance, directly above or a little posterior to angle of jaw; arm free from skin of body; fingers 2-3-5-4 in order of increasing length, toes 1-2-5-3-4; two metacarpal tubercles, of about equal size; sub-articular tubercles distinct on both toes and fingers; two metatarsal tubercles, the inner somewhat larger; a distinct tarsal fold; tibio-tarsal articulation overlapping when femora are at right angles to body; tibio-tarsal articulation reaching to slightly behind or anterior to snout; toes webbed, the webs usually extending to disks, sometimes emarginate, the two terminal phalanges of the fourth toe free; a fold across chest between axillae; postero-ventral aspect of femora and posterior part of abdomen granular, otherwise ventral surfaces of limbs, body and head smooth; dorsal surfaces either smooth or warty, the eyelids always somewhat rugose.

Color above slate-gray; a black, usually light-edged, triangular mark, apex directed caudad, between eyes; frequently a broad, irregular light band down back, whitish, greenish or reddish in color; a light band from eye to preaxilla, bordered above by a dark spot; usually an indistinct dark band from supra-axillary region to sides, disappearing in front of groin; back frequently with small black spots, sometimes surrounding lighter areas or warts; about four bars across labial region on each side of upper jaw; limbs partially banded, or spotted, dorsally; usually a distinct, broad dark line on posterior concealed surface of femora, bordered above and below by lighter; ventral surfaces immaculate, whitish or spotted in breast and gular region; usually a light-colored wart on each side of and below anus.

*Sexual dimorphism:* The gular region in males is expanded to form a sac,

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which is yellow in life and when inflated; the gular and chest region is more frequently spotted in males than in females; the fingers of females are slightly longer.

TABLE 17.  
Measurements of adults

	1	2	3	4	5	6	7	8
Total length	30.0	29.2	32.0	21.8	25.2	29.3	23.8	26.0
Width of head	10.0	9.0	9.5	7.3	8.2	9.0	8.0	8.0
Length of head	6.8	7.8	8.0	6.0	6.3	7.1	6.3	6.8
Hind leg	52.5	52.0	51.2	39.8	45.4	48.5	40.0	46.0
Femur	15.8	14.5	14.8	11.5	13.8	14.0	12.0	13.0
Tibia	16.3	16.8	17.0	12.5	14.0	15.8	12.8	14.5
Tarsus	9.0	9.3	9.0	7.0	7.5	8.8	7.0	7.2
Foot	15.0	15.5	15.0	11.3	13.0	14.0	11.6	13.0
Fore Leg	16.5	15.6	16.0	12.4	14.3	15.0	10.0	13.0
Fore arm	5.0	5.4	5.5	3.9	5.0	5.0	4.8	5.0
Hand	8.0	7.3	8.0	5.7	7.0	6.5	5.5	6.7
Sex	fem.	fem.	fem.	fem.	fem.	male	male	male

Nos. 1 and 6 are from 9 mi. SW of Toronto, Greenwood county; no. 2, Ottawa, Franklin county; no. 3, Doniphan Lake, Doniphan county; no. 4, Douglas county; no. 5, Hays, Ellis county; no. 7, Pratt, Pratt county; no. 8, Arkansas City, Cowley county.

*Larvae:* Described by Wright (1931) in detail.

*Eggs:* Laid singly or rarely in small masses (in the laboratory). Full details are given by Wright (1931). The egg complement of a single female which laid in the laboratory in Lawrence was 248.

*Breeding habits:* Although individuals are sometimes collected throughout the winter, and are rather abundant in March, their breeding activities do not begin until early April (Gloyd, 1928). Near Lawrence clasping pairs have been collected as late as May 9 (1933); they probably breed much later, as their songs are frequently heard as late as July, and Gloyd (personal notes) has heard them singing about Manhattan as late as July 15.

Eggs have been laid in the laboratory at Lawrence on May 10, from females collected the preceding night (1933).

The breeding sites chosen are varied. In regions where the species is found in abundance, permanent lakes, streams and springs always have their quota. Frequently they breed in and sing from temporary pools in pastures or at road-sides.

Amplexation is axillary.

*Food:* Garman (1892) indicates that the food consists largely of aquatic insects. Hartman (1906) states that "ants, a caterpillar, lady-bug, snapping beetles, a spider, one small crayfish and small beetles unidentified" were found in the stomachs of seven individuals. This would indicate a more terrestrial diet. A combination of aquatic and terrestrial food would be expected, but the percentage of each is yet doubtful.

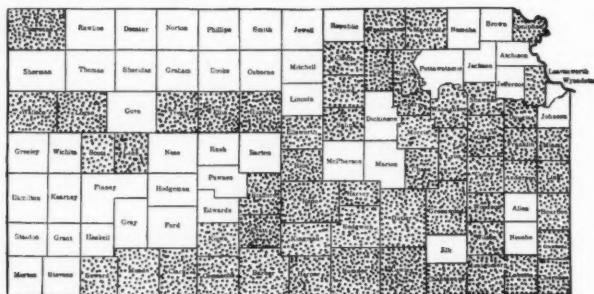
*Habits and habitat:* Linsdale (1927) remarks concerning the habits of *Acris* in winter:

On February 2, 1924, several were found in the creek above the bridge. They were in the water above some old ice and below a top layer of new ice. All the frogs were stiff and floating and were apparently dead.



In the warm water of the springs and just below the springs a few frogs of this species were found throughout the winter.

*Distribution:* "Florida to New York in the east, northward through the central valley from Louisiana and Texas to the Canadian Northwest Territories." (Stejneger and Barbour, 1923).



Map 14. Distribution of *Acris gryllus* (Le Conte).

KANSAS: Probably over the entire state. Actual records are as follows:

ANDERSON COUNTY: 4 mi. S of Garnett (KU 13373); Hyatt (KU 13402-13403). BARBER COUNTY: 7 mi. S of Sun City (KU, 5 spec.). BOURBON COUNTY: (UMMZ 66881, 3 spec.; KU 14000, 14016). BUTLER COUNTY: Walnut River (KU 7905-7906). CHASE COUNTY: 5 mi. W of Saffordville (KU, 3 spec.). CHAUTAUQUA COUNTY: 4 mi. SE of Cedarvale (BMNH); 5 mi. E of Cedarvale (CEB); Pools in Big Coney River, 1/2 mi. SE of Sedan (CEB). CHEROKEE COUNTY: (KU 16117); 3 1/2 mi. N. of Baxter Springs (CEB); 1/2 mi. N. of Cravensville (CEB); near Galena (KU 16046-16052). CHEYENNE COUNTY: Pond on eastern outskirts of St. Francis (CEB). CLARK COUNTY: 4 mi. N. of Englewood (KU, 2 spec.); Bluff Creek, 15 mi. E. of Ashland (KU, 1 spec.). CLAY COUNTY: 5 mi. S. of Clifton (Burt and Burt, 1929b); NE of Clay Center (KU, 16 spec.). CLOUD COUNTY: W. of Miltonvale (KU, 21 spec.). COFFEY COUNTY: 2 mi. W. of Lebo (KU, 1 spec.). COMANCHE COUNTY: Wilmore, 3 mi. E. of (KU, 2 spec.). COWLEY COUNTY: Arkansas City (KU 13384, 13388-13392); 10 mi. NE of Winfield (MVZ); 2 mi. W. of Winfield (USNM 86452-86453); 7 mi. SE of Winfield (CEB); 2 mi. N of Winfield (Burt, 1932); 5 mi. SE of Winfield (Burt, 1932). CRAWFORD COUNTY: Cow Creek, Pittsburgh (KU 7902); Girard, Santa Fe Lake (KU 13615-13620). DONIPHAN COUNTY: (Linsdale, 1927); Doniphan Lake (KU 13371). DOUGLAS COUNTY: (KU 7535, 7716-7738, 7893-7896, 7912-7918, 7931-7935, 7945-7949, 7960-7971, 13395-13398, 13570-13611, 13627-13629, 1439-1440, 14001-14003, 14005-14010, 14012-14015, 14017); Lawrence (Wright, 1931). ELLIS COUNTY: Hays (L. A. Brennan, MS; KU 15616-15618; HMS, 2 spec.). ELLSWORTH COUNTY: Near Arcola, west of Brookville (HMS). FRANKLIN COUNTY: (Gloyd, 1928; OU 328-331, 341-363); Ottawa (KU 13624-13626); 4 mi. NW of Richmond (Burt and Burt, 1929b). GEARY COUNTY: Ft. Riley (Cragin, 1881; Yarrow, 1883; Cope, 1889). GREENWOOD COUNTY: Fall River (KU 7911, 7936-7940); 9 mi. SW of Toronto (KU 16245-16253). HARPER COUNTY: (KU, 2 spec.). HARVEY COUNTY: 4 mi. SW of Walton (KU, 11 spec.). KINGMAN COUNTY: Outskirts of Kingman (KU, 1 spec.). KIOWA COUNTY: 4.5 mi. SE of Belvidere (KU, 1 spec.). LABETTE COUNTY: Big Hill Creek (KU 7907); 3 mi. E. of Parsons (USNM). LANE COUNTY: Pendennis (KU 13511-13513). LEAVENWORTH COUNTY: (KU 7140-7143); 4 mi. NE of Lawrence (KU 7986-7993). LINN COUNTY: (KU

7901). LOGAN COUNTY: (KSC 63065); 3 mi. SW of Elkander (KU 7910). LYON COUNTY: Emporia (Wright, 1931). MARSHALL COUNTY: 2 mi. W. of Waterville (Burt and Burt, 1929b); Elm Creek, Blue Rapids (KU 13394). MEADE COUNTY: State Lake (KU, 3 spec.). MIAMI COUNTY: (KU 7908-7909, MVZ, 29 spec.; UMMZ 20 spec.; USNM, 1 spec.; OU 844-952, 927-929); Pigeon Lake (Gloyd, 1932); Marias des Cygnes River (KU 7897-7900). MONTGOMERY COUNTY: 5 mi. NE of Elk City (CEB); Independence (KU 8024-8066). MORRIS COUNTY: 4 mi. N of Chase-Morris county line, S of Council Grove (KU, 1 spec.). OSAGE COUNTY: Quenemo (KU 13370). OTTAWA COUNTY: SW of Ada (KU, 5 spec.). PRATT COUNTY: Pratt (KU 13411-13419). RENO COUNTY: 4½ mi. SW Medora (KSC); Medora (UMMZ 66878; USNM, 16 spec.). RICE COUNTY: (KU, 1 spec.). RILEY COUNTY: (Burt, 1927; UMMZ, 5 spec.; MVZ, 17 spec.; USNM, 11 spec.; KSC 56); Wildcat Creek (USNM 71488-71492). RUSSELL COUNTY: (HMS, 4 spec.). SALINE COUNTY: Brookville (USNM 89017-26). SCOTT COUNTY: State Lake (KU, 1 spec.). SEDGWICK COUNTY: 3 mi. S of Wichita (KU, 2 spec.). SEWARD COUNTY: Cimarron River, central part of county (KU, 1 spec.). STAFFORD COUNTY: (KSC 66-68); Little Salt Marsh (KU 13386). SUMNER COUNTY: Side pools on bank of Arkansas River 5 mi. E of Belle Plaine (CEB). TREGO COUNTY: (KU 13399-13400, 10719; HMS, 2 spec.). WALLACE COUNTY: (KSC 57-62); Sharon Springs (UMMZ 68623). WASHINGTON COUNTY: 6 mi. E of Haddam (Burt and Burt, 1929b); 6 mi. N of Haddam (Burt and Burt, 1929b); 2 mi. E of Haddam, Nutch's Pond (Burt and Burt, 1929b); 4 mi. SE of Haddam (Burt and Burt, 1929b); 7 mi. SE of Enosdale (Burt and Burt, 1929b); Morrowville (Burt and Burt, 1929b); just W of Washington (Burt and Burt, 1929b). WILSON COUNTY: West of New Albany, riffles and sand bars of Kaw River (KU 13374-13383); 2 mi. N of Neodesha (KU 13372). WOODSON COUNTY: 5½ mi. NE of Coyville (Burt, 1932); Neosho Falls (KU 13401, 13404-13410, 9205).

**History:** That this species existed in Kansas was first indicated by Halliwell (1857a, p. 251), who mentions a specimen "resembling the *Acris gryllus*." As he was not certain of it himself, it cannot now be positively assumed that his assumptions were correct. Cragin (1881) was first to definitely report this species from the state, from Ft. Riley and 150 miles west of Ft. Riley. Yarrow (1883) reported it also from Ft. Riley, and from 105 miles west of Ft. Riley. Cope (1883) gave the same. Hartman (1906) mentions the species from Kansas, but no new definite locality records appear until Burt (1927) reported it from Riley county. Since then records have frequently been added: Doniphan county (Linsdale, 1927); Franklin (Gloyd, 1928); Clay, Franklin, Marshall and Washington (Burt and Burt, 1929b); Lyon and Douglas (Wright, 1931); and Miami (Gloyd, 1932).

**Remarks:** *Acris crepitans* Baird was the form Cragin (1881), Yarrow (1883) and Cope (1889) reported from Kansas. Cope distinguishes it (1889) as a subspecies of *gryllus* as follows:

Hinder foot less tarsus less than half the length of the head and body; dermal tubercles larger; posterior femoral stripe less distinct—*A. g. crepitans*.

Hinder foot less tarsus longer than half head and body; dermal tubercles smaller; femoral stripe very indistinct—*A. g. gryllus*.

If this form actually exists, as Viosca (1923, 1931) maintains, it certainly does not in Kansas. The specimens examined are too uniform in character to permit of more than one species, and the extent of variation is well within that of *gryllus*. Viosca (1923) states that *crepitans* is of the lowlands, *gryllus* of the uplands.

*Pseudacris clarkii* (Baird)

*Helocaetes clarkii* Baird (1856, p. 60).

*Helocaetes clarkii* Baird (1859, p. 28, pl. 37, figs. 4-9).

Cope (1889, pp. 346-347). Mentioned as a 'form' of *triseriata*.

Strecker (1908, p. 58). Recorded from various localities in Texas. Regarded as a 'variety' of *triseriata*.

Strecker and Williams (1928, p. 9). Remarks that it "seemingly is as distinct from *feriarum* as either *triseriata* or *nigrita*."

*Chorophilus triseriatus clarkii* [sic] Cope (1880, p. 28). Recorded from various localities in Texas.

*Chorophilus triseriatus clarkii* Cope (1893, p. 333). Notes on habits.

Cope (1894b, p. 386). First report from Oklahoma.

Strecker (1902, p. 7).

C. [horophilus] *triseriatus clarkii* Strecker (1908, p. 82). Mentions that the species is not worthy of recognition.

*Holocaetes* [sic] *clarkii* Strecker (1915, p. 48). Apparently considered as a synonym of *triseriata*.

*Pseudacris nigrita* Ortenburger (?) [nec Le Conte] (1916, p. 92). Recorded from Creek county, Oklahoma.

*Pseudacris triseriata clarkii* Burt (1932, p. 80). Recorded from Kay county, Oklahoma.

*Type locality*: Galveston and Indianola, Texas.

*Diagnosis*: A small (35 mm.) hylid, general body form elongate and thin; vomerine teeth present, in round patches; digital disks minute; webs between toes very rudimentary; tibio-tarsal articulation reaching to between axilla and tympanum; dorsal ground color light slate, dorsal pattern of large, irregularly placed spots never arranged in longitudinal stripes; typically, a triangular mark between eyes; head broader, eyes larger and tympanum larger than in *triseriata*.

*Comparisons*: The practical absence of webs between the toes, and the presence of a distinct tympanum (indistinct in *Gastrophryne*), distinguish this from all other salientia of Kansas except *Pseudacris triseriata*. From this it differs as follows:

1. *Clarkii* is never striped; *triseriata* usually is, and if spotted, the spots are usually arranged in rows, having been derived from stripes, and are smaller than in *clarkii*.

2. *Clarkii* rarely does not have a triangular mark between the eyes; *triseriata* rarely does have.

3. The tympanum of *clarkii* is in contact or very slightly removed from the angle of the lower jaw; in *triseriata* it is farther removed from the angle of the jaw, and is distinctly smaller.

4. The head of *clarkii* is broader than that of *triseriata*, entering the body length 3.0 to 3.2 times in the former, and from 3.3 to 4.0 times in the latter.

5. The eyes of *clarkii* are somewhat larger and more prominent than those of *triseriata*.

6. The song as described by Cope (1892) is different from the song produced by *triseriata*.

7. The light line bordering the upper jaw in *clarkii* seldom has a dark line below it, as typically occurs in *triseriata*, but is continuous to the edge of the jaw.

8. The legs of *clarkii* are longer, the tibio-tarsal articulation extending forward to between orbit and tympanum, while in *triseriata* it reaches to between axilla and tympanum.

9. The dorsal surface of the hind limb of *clarkii* are smooth, but rugose or granular in *triseriata*.

10. The breast is usually spotted in *triseriata*, but immaculate in *clarkii*.

Other differences between these two closely related species will no doubt appear when their larvae and eggs are well known.

*Description:* (From specimens from Cleveland county, Oklahoma. The Kansas specimens are somewhat distorted by too strong preservative.) Head rather flat, elliptical in dorsal profile; snout pointed in lateral profile; lores angular, at about 45 degrees, slightly concave; internarial and interorbital distance about equal; orbits rather large, longitudinal diameter  $1/4$  to  $1/3$  greater than the internarial distance; tympanum rather large, round, in contact with or very slightly separated from angles of jaw, separated from orbit by less than half its own diameter, bordered above by a fold of skin; tongue rather large, nearly filling cavity of lower jaw; vomerine teeth in two small, round series between and behind or even with posterior borders of choanae, the distance between about equal to the distance of either from the internal nares; a fold across chest between axillae; skin of body not extending out on forelegs; two or three metacarpal tubercles, subarticular tubercles distinct; fingers not webbed, 2-3-5-4 in order of increasing length, toes 1-2-3-5-4, 3 and 4 about equal; tibio-tarsal articulations overlapping somewhat as femora are held at right angles to body and legs flexed, reaching to between tympanum and orbits; two metatarsal tubercles, the inner somewhat larger; subarticular tubercles distinct; ventral surfaces of belly granular except a smooth mid-ventral area behind fore-legs; ventral surfaces of limbs smooth, except posterior surfaces of femora, the anterior surfaces of which are smoother than in *triseriata*; dorsal surfaces of body very inconspicuously granular, almost smooth; limbs smooth above, sides granular.

Light slate above, with promiscuously placed, rather large to medium-sized spots, never arranged in longitudinal rows; usually a triangular mark between eyes, limbs distinctly banded except on concealed and ventral surfaces; venter immaculate, whitish.

*Sexual dimorphism:* The males have blackish gular pouches, with three or four longitudinal plaits, irregularly placed.

TABLE 18

## Measurements of adults

Length of body	29.7	30.4	30.8	31.0	Tibia	13.7	14.0	14.0	13.4
Width of head	9.5	9.8	10.0	10.0	Tarsus	9.0	9.2	9.0	7.6
Fore leg	13.8	15.0	16.2	16.0	Foot	14.0	14.7	14.1	14.1
Femur	13.5	14.5	12.8	13.8	Hind leg	46.0	48.0	48.1	47.0
Sex	male	male	male	male	Sex	male	male	male	male

From the Rush county specimens.

*Variation:* There is apparently less variation in *clarkii* than in *triseriata*. The dorsal spots may in some be very numerous, some fused with others,

while in other specimens the spots are but few (12 or so) and somewhat larger.

*Larvae:* Unknown.

*Development:* The 18 specimens from Sedgwick county, collected September 1, 1933, had transformed very recently, a few retaining rudiments of the tail. They were from 13.5 mm. to 17.0 mm. in head and body length, the smaller specimens having the tail rudiments.

*Song:* Cope (1892) remarks that

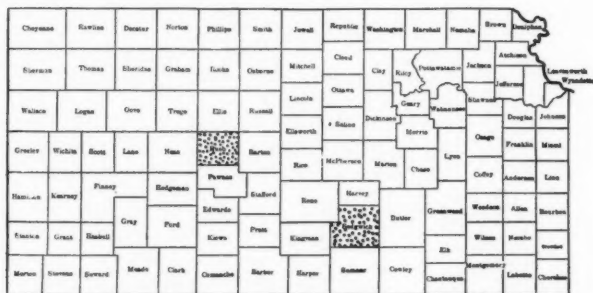
"They sit immersed in the water, with the head projecting, uttering their cry, as they inflate the enormous vocal sac, to which the head appears to be but an appendage. The voice differs from that of the form *triseriatus* in its more rapid utterance, and the greater distinctness of the rising inflection at the end."

*Breeding habits:* In Oklahoma *clarkii* were heard singing on the night of June 2 (1932), from temporary pools formed by heavy rains a day or two earlier.

Amplexation is presumably axillary.

*Habits and habitat:* The specimens found in Oklahoma were in wooded areas. They seemed to avoid the deeper, muddier, less protected pasture pools where *Scaphiopus* and *Bufo* were numerous. Some were found, however hopping about in the grassy fields, not far distant from pools. The specimens from Sedgwick county, Kansas, were found in a habitat essentially similar to the above, except that the pool in which they were found was permanent, while the other apparently was not.

*Distribution:* Central Texas north through central Oklahoma to central western Kansas.



Map 15. Distribution of *Pseudacris clarkii* (Le Conte).

**KANSAS:** The present record of this species in Kansas are too scanty for a definite mapping of the distribution within its borders. The only actual records are:

**RUSH COUNTY:** Nekoma (KU 4511-4516). **SEDGWICK COUNTY:** 10 mi. N of Wichita (KU, 18 spec.).

*Remarks:* The history of this species has been a long and hectic one. The older herpetologists were apparently none too certain of its status, and

Strecker, who was concerned with it more directly than any other herpetologist, changed his views with each forthcoming paper. The Kansas and Oklahoma specimens have been considered by some to be *nigrita*, while in fact they are no more similar to this than to *triseriata*, which is apparently closely related to *nigrita*. The existence of the two Kansas species side by side (Nekoma, Rush county), retaining their identity even under such conditions, is ample witness of their distinctness. But to determine the exact identity of Baird's type is by no means simple, as his description is brief and conveniently inclusive:

Snout acute, projecting. Extremities somewhat dilated. Tibia half the distance between eye and anus. Foot but little longer, not nearly half the length of body. Above grayish brown or ash, with distinct large circular blotches. A dark band from snout through eye and tympanum down the sides, and a whitish line on the side of the jaw. Size about one inch long.

In view of his superficial description, it was indeed most fortunate that Baird later figured the species in his Boundary Survey. Whether or not the specimen he figured was his type, it is still extant in the U. S. National Museum. Dr. Taylor examined this specimen, and remarked that, although faded, it agreed in every marking with Baird's figure.

The extension of the range of the species northward has been a gradual and continuous one, with the proper interpretation of the recorded species, so that the discovery of the species in Kansas is not so surprising. Cope extended its range to northern Texas (Dallas) in 1880, and into Oklahoma in 1894, shortly after recording it from the panhandle of Texas (1893). Ortenburger then (1926) reported *nigrita* (almost certainly *clarkii*, by this interpretation) from Creek county, Oklahoma, a record verified by a specimen from the same locality in the KU museum, collected by Dr. Taylor. Burr (1932) found it in Kay county, Oklahoma, and subsequent collecting and examination of the KU material has revealed its existence far northward into central Kansas, in essentially the same ecological relations as exist where it is found in central Oklahoma.

***Pseudacris triseriata* (Wied)**

SWAMP CRICKET FROG

*Hyla triseriata* Wied (1838, p. 249).

*Chorophilus triseriatus* Coues and Yarrow (1879, p. 290). Reported from "Kansas" on the basis of specimens in the U. S. National Museum.

Cragin (1881, p. 118). No definite localities in Kansas given. Food.

Cope (1889, pp. 342-347). Recorded from Blue River, Kansas.

Hartman (1906, p. 228). Food in Kansas.

Ellis and Henderson (1915, pp. 257-258, pl. 1). Remarks on life history and variation.

*Chorophilus triseriatus triseriatus* Yarrow (1883, p. 170). Recorded from Blue River, Kansas.

*Pseudacris triseriata* Pack (1920), p. 7). Eggs.

Wright and Wright (1924, pp. 375-381). Description of eggs.

Strecker (1926a, pp. 8, 11). Incidental remarks concerning life history.

Linsdale (1927, p. 77). Recorded from Doniphan county.

Gloyd (1928, p. 117). Recorded from Franklin county; notes on life history.

Tanner (1931, pp. 183-185). Food.



Gloyd (1932, p. 396). Recorded from Miami county; notes on life history.

*Hyla triseriata* Noble (1923a), pp. 1-6).

Cahn (1926, pp. 107-109). Records a set of albino eggs of *triseriata*.

Burt and Burt (1929a, p. 5). Recorded from Montgomery and Washington counties.

*Type locality:* Mt. Vernon, Ohio River, Indiana.

*Diagnosis:* A small (35 mm.) hylid, general body form elongate and trim; vomerine teeth present; digital disks minute; webs between toes very rudimentary; tibio-tarsal articulation reaching to between axilla and tympanum; dorsal ground color of varying shades of slate; three dorsal stripes of dark gray, sometimes broken into spots; rarely a complete triangle between eyes, usually a round spot on each eyelid; tympanum small; eyes small.

*Comparisons:* *Triseriata* differs from all other salientia of Kansas except *Pseudacris nigrita* in the nearly complete absence of webs between the toes. From the latter it differs in rarely having a distinct triangular mark between the eyes, in the usually striped, seldom spotted, pattern, in the smaller tympanum, smaller eyes, somewhat greater maximum size, apparently more narrow head and general slimmer build.

*Description:* Head rather flat, elliptical in dorsal profile; snout broad to pointed in dorsal profile, pointed in lateral profile, projecting beyond the lower jaw; lores angular, at about 45 degrees, slightly concave; internarial, orbitonarial and interorbital distance about equal; eyes small, the longitudinal diameter greater than or equal to the internarial distance; tympanum round, bordered above by a fold of skin, separated by about 1/3 of its own diameter from angle of jaw, and by about 3/4 of its diameter from orbit; diameter of tympanum 1/2 to 3/5 the internarial distance; tongue round, nearly filling the cavity of the lower jaw; vomerine teeth in two small patches, round or elongate, situated slightly posterior to and between internal nares, nearer each other than the nares; latter moderate, posterior to and more widely separated than external nares; skin of body not extending out on foreleg; two metacarpal tubercles, inner largest; numerous plantar and sub-phalangeal tubercles on hand; fingers not webbed, terminal disks minute, scarcely enlarged; tibio-tarsal articulations overlapping on flexed legs, femora at right angles to body, and extending forward to between axilla and tympanum; two metatarsal tubercles, outer about twice as large as inner; subarticular tubercles of foot rather conspicuous, plantar tubercles small; toes scarcely webbed, the webs between fourth and fifth, and third and forth, largest, others frequently hardly visible; whole body except ventral surfaces of tibiae and foot and gular region, granular (occasionally a smooth area in anterior part of belly); granules largest but most indistinct midventrally posterior to axillae, somewhat smaller in posterior part of belly, less numerous on back, smallest in mid-dorsal region, on top of head and on limbs.

Color light slate above, typically with three broad dark slate stripes down the back; mid-dorsal stripe frequently broken, others less frequently; rarely a triangular mark between eyes; a dark spot covering each eyelid frequently present; transverse elongated spots present on limbs; feet usually pigmented; ventral surfaces whitish, a few small black spots usually present on breast.

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*Sexual dimorphism:* Males possess gular vocal pouches, usually with four or five longitudinal plaits.

*Variation:* It is well known that numerous color variations are found. Ellis and Henderson (1915) discuss this in detail, having taken from a single pool forms with only stripes, and with spots only on eyelids, others with stripes and the spots on eyes fused with the mid-dorsal stripe, others with only spots, and still others with various other combinations. They quite possibly confused *nigrita* with *triseriata*.

The webbing between the toes varies considerably, the webs in some being comparatively large, but almost absent in others.

TABLE 19  
Measurements of adults

	1	2	3	4	5	6	7	8
Body length	23.4	23.8	24.9	24.5	28.0	28.0	28.1	25.5
Width of head	6.8	7.0	7.5	7.2	7.9	7.8	7.1	7.8
Fore leg	13.0	13.0	13.0	13.0	14.0	14.0	14.0	14.5
Hand	5.0	4.5	5.0	4.8	5.2	5.2	5.8	5.0
Femur	8.0	8.8	9.0	9.3	11.0	11.2	11.2	10.5
Tibia	8.8	8.8	9.0	9.3	10.9	10.8	11.0	10.8
Tarsus	6.2	6.8	6.5	6.7	8.0	7.5	7.8	7.6
Foot	13.0	11.0	11.0	10.1	12.5	12.0	12.8	11.5
Whole leg	29.0	32.3	33.3	32.0	40.0	38.0	40.0	38.0
Sex	fem.	male	male	male	male	fem.	male	male

Nos. 1-4 are from south of Haskell, Douglas county, (KU 7739-7742); Nos. 5-7 are from Haskell Meadows, Douglas county, (KU 7650-7652); No. 8 is from five miles north of Garnett, Anderson county, (KU 7273).

*Larvae:* Unknown, except that (Ellis and Henderson, 1915, p. 257) they resemble those of *Bufo woodhousii woodhousii*: "immediately after leaving the eggs were very black and about 8mm. in length."

*Eggs:* Dickerson (1906) states that the eggs are laid "in small bunches of from five to twenty eggs." Pack (1920) states that "The number of eggs in the twenty two egg masses taken were as follows: 66, 45, 53, 33, 65, 46, 88, 38, 40, 67, 32, 50, 64, 87, 77, 15, 65, 51, 73, 45, 130, 190." Wright and Wright (1924) state that there are from 20-100 eggs in each mass. Strecker (1926, p. 11) remarks that the eggs are in bunches of from ten to twenty-five.

In Kansas the eggs are more numerous in their respective masses than these previous accounts would indicate, numbers varying from 110-300, the mode being about 140.

Wright and Wright (1924, p. 381) give 500-800 as the egg complement. One female observed by the writer laid 1,459 eggs during a single night in the aquarium in which she was isolated.

The membranes of the eggs from females collected near Lawrence differ somewhat from the type figured by Wright and Wright (1924, pl. 1, fig. 7). The outer envelope is typically about 3.0 mm.; there was, in several bunches of eggs, a second membrane about 2.1 mm. in diameter; the vitellus is as given by Wright and Wright (0.9 to 1.2 mm.). The latter authorities describe the individual eggs as follows: "outer envelope merged; the one envelope 5.0 to

7.8 mm., rarely 3.0 mm.; vitellus 0.9 to 1.2 mm." There is always a vitelline membrane closely applied to the vitellus.

Albino eggs have been recorded by Cahn (1926). Chromatophores developed later in the larvae, although slowly.

*Song:* Cope (1889) ably describes the song as follows:

It may be imitated by drawing a point across a coarse comb, commencing at the bottom of a jar and bringing it rapidly to the mouth; or, better, by restraining the voice to the separate vibrations of the vocal cords, and uttering a bar of a dozen or twenty vibrations, beginning with the mouth closed and ending with it well opened.

*Breeding habits:* Wright and Wright (1924) state that the breeding season is March 19-May 1 (east of the Mississippi River). This is approximately the season in Kansas, except that it may start 15 days to a month earlier, as Gloyd (1928) states that "The notes of the swamp tree frogs were sometimes heard during the first week of February, when they appeared as soon as a slight moderation in the weather and rise in temperature permitted..... Mated pairs were collected and egg masses attached to plant stems in water were observed March 6." Near Lawrence I have observed egg masses as late as April 28, at which time choruses of this frog were yet to be heard.

Amplexation is axillary.

*Development:* Dickerson (1906) states that

Eggs laid March 22 hatched April 5th. . . By April 20th the eggs are budded. The tadpoles are now one-half inch, are black in color, finely dotted with gold, and with the underparts very brilliantly copper-tinted.

The final transformation takes place from May 26th to June 12th, when the tadpole is slightly over an inch long. . . The stripes on the back do not appear until the creatures are actually on the point of leaving the water.

Gloyd (1928) reports transformation on May 15, or an equivalent of about two months for complete development from the eggs to transformation.

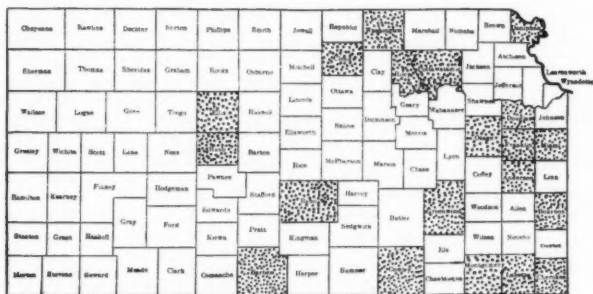
*Food:* Cragin (1881) states that the stomach of one specimen he examined contained a grub, a beetle, a small spider, together with certain extraneous matter. Hartman (1906, p. 228) found them with spiders, ants and algæ (the latter in the stomachs of young specimens). Tanner (1931, p. 184-185) found a predominance of spiders, a nearly equal amount of Carabidæ, some Diptera, Hemiptera, and a number of aquatic larvae. These data indicate that the food is about equally divided between aquatic and semi-aquatic. Probably no strictly terrestrial food is eaten consistently.

*Habits and habitat:* The usual habitat of this frog is swampy, marshy places, where they are abundant in spring. At this time of the year they may be found about temporary pools at roadsides or in pastures, or in small streams, although never, probably, in the abundance that they occur in more marshy regions, as along lake shores, in flood plains, etc. During summer and fall, when they seldom or never sing, they are rarely found.

Their swimming powers are not great, since they lack the webs between the toes. Dickerson (1906, p. 160) states that the young frogs are such poor swimmers that they "are drowned unless they have the opportunity to leave the water." As the terminal adhesive disks are also minute, they seldom climb far above the water on twigs, trees, etc.

Tanner (1931) remarks that they are found to an elevation of 11,000 feet in the Uintah Mountains of Utah.

*Distribution:* "Alleghany Mts. to New Mexico, Arizona, and Idaho." (Stejneger and Barbour, 1923).



Map 16. Distribution of *Pseudacris triseriata* (Wied).

KANSAS: Has been taken in various places over the eastern 2/3 of the state, and probably ranges over the entire state. Actual records are as follows:

ANDERSON COUNTY: Garnett, 5 mi. N of (KU 7273). BARBER COUNTY: Kiowa (USNM 45828. I have not seen this; may be *nigrita*). BOURBON COUNTY: (KU 14035-14036), Ft. Scott (HMS). CHEROKEE COUNTY: (KU 14031-14034); Cloud County: West of Miltonvale (KU, 7 spec.). COWLEY COUNTY: 7½ miles SE of Winfield, head of Badger Creek (HMS). DONIPHAN COUNTY: (Linsdale, 1927). DOUGLAS COUNTY: (KU 3454-3457, 7648-7654, 7739-7742, 8072, 8073, 8083-8092, 13651, 13652, 15635, 16027-16035, 7144-7154, 14020-14024, 14026-14030). ELLIS COUNTY: Hays (KU 15634). FRANKLIN COUNTY: (Gloyd, 1928; FMNH, 2 spec.; OU 332-340, 786-813); Ottawa (KU 13645-13650). GREENWOOD COUNTY: Toronto, 9 mi. SW of (KU 16254-16269). LABETTE COUNTY: Oswego, 9 mi. SW of (KU 13612-13614); Montana (HMS, 2 spec.). MIAMI COUNTY: (FMNH, 8 spec.; OU 853-863; UMMZ 66373, 66875-66876). Pigeon Lake (Gloyd, 1932). MONTGOMERY COUNTY: Cherryvale, 5 mi. N. of (Burt and Burt, 1929a); Morehead, 7 mi. S of (Burt and Burt, 1929a). OSAGE COUNTY: Carbondale (KU, 5 spec.). POTTAWATOMIE COUNTY: Onaga (USNM 45921). RENO COUNTY: Medora (FMNH). RILEY COUNTY: Manhattan (FMNH). RUSH COUNTY: Nekoma (KU 4509-4510). WASHINGTON COUNTY: Barnes, 2 mi. SE of (Burt and Burt, 1929a).

**History:** Apparently the first mention of Kansas in the range of *Pseudocris triseriata* was that of Coues and Yarrow in 1879. Cragin (1881) mentioned it from Kansas, but gave no definite localities. Yarrow (1883) records one from "Blue River," and Cope (1889) also. Hartman (1906) mentioned it from Kansas, but no new locality records appeared until 1927, when Linsdale reported it from Doniphan county. Gloyd reported it from Franklin county a year later, Burt and Burt (1929a) from Washington and Montgomery counties, and Gloyd (1932) from Miami county. Five definite county records have thus been published in the past. One new locality record given here—Riley county—is the only addition to the fauna of that county, as given by Burt (1927), Gloyd (1929) and H. M. Smith (1931), given in this discussion.

*Hyla crucifer* Wied

## SPRING PEEPER

*Hyla crucifer* Wied (1838, p. 275). Described from Cantonment Leavenworth, Kansas.

*Hyla pickeringii* Cope (1889, pp. 352-355).

Overton (1914, pp. 33-34, pl. 7, figs. 30-32.).

Wright (1914, pp. 35-43, pl. 13). A complete discussion of life history.

*Hyla crucifer* Munz (1920, pp. 49, 52-55). Food.

Noble and Noble (1923, pp. 424-425, 441). Notes on egg-laying.

Babcock (1926), pp. 11-14).

Gloyd (1932, pp. 396-397). Reported from the state for the second time.

*Hyla crucifera* Myers (1929, pp. 22-23).

*Type locality:* Cantonment Leavenworth, "Kansas."

*Diagnosis:* A small, smooth-skinned *Hyla* with distinct digital disks and rather restricted but not rudimental webs between toes; snout pointed in all profiles; posterior concealed surfaces of femora blotched; dorsal color brownish, with a darker band between the eyes, a more or less cross-shaped mark on anterior part of back, and several narrow cross-bands on limbs.

*Comparisons:* This is one of the smallest of North American *Hylas*. The coloration and pattern are absolutely distinctive. The presence of intercalary cartilages and the cross-mark on the back distinguish it from other Kansas amphibians. The other *Hyla* in Kansas, *v. versicolor*, differs in the larger size, broader head, less pointed, almost truncate, snout, in the greater extension of the webs of the toes (to terminal disks of third and fourth toes in *versicolor* but not in *crucifer*), and in other respects easily visible.

*Description:* Head somewhat flattened, median dorsal surface plane, elliptical in dorsal profile; snout pointed in all profiles, protruding slightly beyond lower jaw, the latter but slightly in front of nares; lores angular, at about 65 degrees from horizontal at top of head, slightly concave; nares nearer tip of snout than orbits; internarial distance and orbitonarial distance about equal, somewhat less than interorbital distance; longitudinal diameter of orbit about 1/3 of itself greater than the internarial distance; tympanum small, round, about 2/3 internarial distance, removed from angle of jaw by about 1/2 its own diameter, from orbit by about 3/4; a distinct dermal fold over tympanum, extending from posterior margin of eyelid to forearm; tongue round to oval, moderate in size, faintly notched behind, about 1/3 as broad as cavity of lower jaw; vomerine teeth in two small round patches between and slightly posterior to or on a level with the posterior border of internal nares, separated from each other as far as from the nearest narial openings; internal nares rather small, posterior to external nares and separated slightly more than external nares; a fold across chest between axillae; skin of body extending out on forelegs; metacarpal tubercles not distinctly enlarged; subarticular and plantar tubercles moderately distinct; no webs on fingers, latter 2-3-5-4 in order of increasing length, toes 1-2-3-5-4, 3 and 5 about equal; disk on fourth finger but slightly smaller than tympanum; disk on second finger considerably smaller, on third and fourth but slightly smaller; a distinct metatarsal tubercle and tarsal fold; subarticular tubercles distinct; webs on toes extending to antepenultimate phalanx of fourth toe, to penultimate on the remainder;

tibio-tarsal articulations distinctly overlapping when legs are flexed and the femora are at right angles to the body, extending forward to orbit; ventral surfaces of body and femora granular, otherwise smooth; dorsal surfaces smooth to faintly rugose, top of head usually rugose.

Color above light brown, with darker brownish, narrow markings forming a band between eyes, a cross extending from eyes to the mid-lumbar region, and an inverted v-shaped mark in front of the anus; frequently a band connecting the arms of the cross; limbs narrowly banded; ventral surfaces yellowish, immaculate.

*Sexual dimorphism:* Males have blackish or dark brown blotched gular sacs and their thumbs are slightly enlarged.

*Variation:* A moderate amount of variation obtains in the dorsal markings, but usually not to the extent of obliteration of the cross-mark.

*Larvae:* Described by Wright (1919, pp. 41-42)

*Eggs:* Described by Wright (1919, pp. 40-41)

*Song:* Overton (1914, p. 33) describes this as follows: "The sound made by a spring peeper has the quality of a shrill whistle. Its pitch is very high, about C two octaves above middle C. It rises about half a tone during the peep. Each peep lasts about half a second, and is repeated for ten or twenty or more times at intervals of about a minute. The sound may be imitated by whistling the notes at a pitch about as high as one can ordinarily whistle." A chorus sounds like the jingling of sleigh-bells.

*Breeding habits:* The breeding season is apparently, as in the east, very early. Gloyd (1932) records singing or clasping individuals from March 15 to March 24 (1927, 1928). Breeding no doubt begins earlier than this. Babcock (1926) records March 26 as the average date of first spring emergence in New England—the first of all salienta there to emerge from winter quarters.

Further details are given by Wright (1914) and Noble and Noble (1923).

*Development:* Wright (1914) remarks that eggs hatch in from 4-5 days (one record of 15 days), and that transformation requires about 90-100 days.

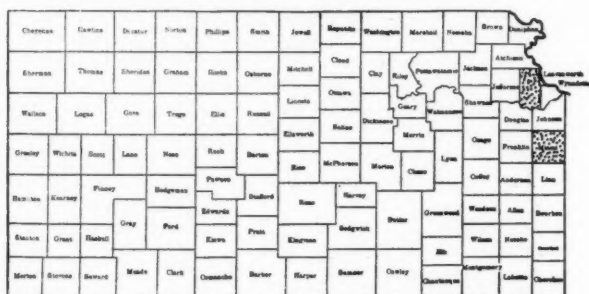
*Food:* Munz (1920) found that the food of *Hyla crucifer* is entirely non-aquatic in both adults and newly-transformed individuals. Hemiptera, Diptera, Coleoptera and Hymenoptera were included, with a predominance of typically flying forms—Diptera and Hemiptera.

*Habits and habitat:* Wright (1914, p. 31) states that "In the spring it seems to manifest no particular preference of habitat. It occurs in myriads in the open lowland marshes, and revels in the swamps at the sources of our streams whether wooded or open, sphagnum or cat-tail. In fact, it seeks any ditch, pool, or pond, transient or permanent, grassy or muddy."

Gloyd (1932) reported this form in Kansas from Pigeon Lake on the flood plain of the Marias des Cygnes river. "They sang from perches upon fallen rushes and sedges a few inches above the water and appeared to be more abundant in the open marsh . . . than among the trees farther back from the open water."

*Distribution:* "New Brunswick to Manitoba, south to South Carolina, Louisiana, Arkansas and Kansas." (Stejneger and Barbour, 1923).



Map 17. Distribution of *Hyla crucifer* Wied.

KANSAS: Only along the extreme eastern border of the state. Actual records are:

LEAVENWORTH COUNTY: Cantonment Leavenworth (Wied, 1839). MIAMI COUNTY: Pigeon Lake (Gloyd, 1932; OU 814-818, 833-843; UMMZ 66871 (3), 66872(3), seven spec.; USNM, 7 spec.; MVZ, 5 spec.).

Remarks: The nearest records of this species to Kansas are those from western Missouri (St. Clair county) by Hurter (1911).

#### *Hyla versicolor versicolor* Le Conte

##### TREE TOAD

*Hyla versicolor* Le Conte (1825, p. 281).

Cragin (1881, p. 118). Recorded from "Kansas."

Cope (1889, pp. 373-377, pl. 64, fig. 95). No Kansas records.

Hartman (1906, p. 228).

Overton, (1914, pp. 32-33, pl. 7, figs. 26, 27).

Wright (1914, pp. 44-51, pl. 14). A complete discussion of life history.

Pope, P. H. (1919, pp. 66-67). Longevity.

Munz (1920, pp. 49-50, 52-55). Food.

Babcock (1926, pp. 11-14).

Linsdale (1927, p. 76). Recorded from Doniphan county.

Wright (1931, pp. 325-333). Additional notes on life history.

*Hyla versicolor versicolor* Dice (1923, pp. 43, 44, 45). Recorded from Riley county, thus giving the first definite locality within the state.

Burt (1927, p. 3). Riley county.

Gloyd (1928, p. 117). Recorded from Franklin county.

Gloyd (1932, pp. 397-399). Recorded from Miami county.

*Hyla phaeocrypta* (sic) Burt (1928, pp. 630-631).

Type locality: Northern States.

**Diagnosis:** A moderately-sized, rough-skinned *Hyla* with large digital disks, nearly complete webs on toes, and slight webs between fingers; posterior surfaces of femora blotched; color and markings very variable, but typically grayish, with a roughly 5-edged star-like marking in anterior mid-dorsal region; concealed surfaces of femora, groin and tibia orange.

**Comparisons:** The large digital disks distinguish this frog from all others in Kansas save *H. crucifer*. From this it differs in never assuming a brown-

ish color as in the other, but the absence of a distinct cruciform pattern as in *crucifer*, and in the greater extent of the webs of the toes.

From the subspecies *chrysoscelis*, *versicolor* differs in having a blotched instead of an immaculate posterior surface of femora, a more rugose skin, and in attaining somewhat greater size. The two forms are apparently distinct enough as subspecies.

According to Viosca (1928), his *avivoca* differs from *versicolor* in smaller size, in the position of the greater part of the dorsal dark markings posterior to the middle of the back; in the green coloration of the concealed surfaces of the femora, tibiae and groin; in the bird-like call; in the "less squat and more slender form," and in the "truncate muzzle and more protuberant eyes"; and in the nearly smooth dorsal integument.

*Description:* Head broadly oval, median dorsal surface plane, snout almost obliquely truncate, slightly rounded; internarial distance and orbitonarial distance about equal, interorbital distance somewhat greater, slightly less than longitudinal diameter of orbits; tympanum large; latter round, slightly less in diameter than internarial distance, directly above angle of jaws and separated from latter by  $1/4$  to  $1/5$  its own diameter, and almost in contact with orbit; a strong dermal fold overlapping tympanum above, extending from posterior margin of orbit to above axilla; tongue large, almost round, occupying all but about  $1/3$  of the cavity of the lower jaw, with a small lobe on each side at the posterior end; teeth in two elongate, parallel transverse patches, almost in contact, separated from the internal nares on each side by the length of one patch; internal nares about even with vomerine teeth, small, posterior to and somewhat farther apart than external nares; a fold across chest between axillae; skin of body not extending out on forelegs; fingers slightly webbed; disk on second finger much smaller than on the others; a distinct dorsal fold between forearm and hand; a tubercle present at base of thumb; palmar surfaces granular; subarticular tubercles present; fingers 2-3-5-4 in order of increasing length, toes 1-2-3-5-4, 3 and 5 about equal, fifth finger but slightly shorter than fourth; a large inner and usually a very small outer metatarsal tubercle; plantar surfaces granular, subarticular tubercles distinct; toes nearly fully webbed, disk on first toe considerably smaller than those of 3, 4, and 5. that on the second toe but slightly smaller; ventral surfaces of body and limbs granular except on tibiae, tarsus and foot; dorsal surfaces somewhat granular, especially about head; tibio-tarsal articulations extending forward to orbit or beyond, not quite touching as legs are flexed and femora are at right angles to body.

Color above, normally, light gray, with darker gray, black-outlined markings, frequently forming a bluntly 5-pointed irregular star-shaped mark in the pectoral region; a band across each upper eyelid; a dark line from posterior margin of eye to groin; limbs broadly banded; posterior concealed surface of femora reticulated or blotched with darker; concealed surfaces of femora, tibiae and groin orange (in life).

*Sexual dimorphism:* Males have black gular pouches and enlarged "thumbs."

*Variation:* The color variation is well-known. This frog, perhaps more than any other in North America, is capable of marvelous changes in the dorsal appearance, varying from uniform light gray and strongly marked gray, to bright pea-green with no markings at all. The dorsal markings, when present, are extremely variable, sometimes scattered over the back in irregular blotches, at other times forming the typical star-shaped mark in the pectoral region.

TABLE 20  
Measurements of adults

	1	2	3	4	5	6
Body length .....	32.0	28.1	43.2	45.8	39.0	38.0
Width of head .....	18.5	10.0	15.5	15.5	14.0	14.1
Fore leg .....	20.0	16.0	27.0	27.0	24.2	23.2
Femur .....	19.0	13.2	21.8	22.5	19.0	20.0
Tibia .....	18.0	14.0	21.4	21.8	19.3	19.0
Tarsus .....	9.7	8.8	13.1	13.5	11.8	12.0
Foot .....	16.0	19.0	20.0	20.3	18.0	13.0
Hind leg .....	55.6	45.0	70.0	72.0	63.0	65.8

Nos. 1-6 are from Douglas county (KU 8124, 8125, 7339, 7338, 8122 and 8126 respectively).

*Description of larvae:* Given in detail by Wright (1914, 1931).

*Description of eggs:* "Eggs deposited in a mass. Mass a surface film. Egg envelope outline distinct, more or less merged in the jelly mass; jelly gelatinous; eggs brown above, cream or yellow below. Egg packets small, seldom if ever over 20 sq. in. (125 square centimeters), or 4 by 5 inches in diameter (10 by 12.5 cm.) Inner envelope small, 1.4 to 2.0 mm.; outer envelope 4 to 8 mm. Packets small, seldom over 30 to 40 eggs; vitelline 1.1 to 1.2 mm. Egg complement, 1802. Season May 10 to August 12." (Wright, 1931, p. 330.)

*Song:* Overton (1914, p. 32) describes the song, as frequently heard in Kansas, as follows: "The voice of the tree frog is a loud, musical trill, like a low-pitched whistle. It may be recognized by its extremely pronounced trill. Each individual call lasts about two seconds, and may be repeated at intervals of ten to twenty seconds." Published accounts of the song vary somewhat, so that one might suspect the frog actually is different, or the songs vary. Gloyd (1932) remarks that "Their calls varied considerably in pitch, with an occasional cry so different as to lead one to suspect the presence of another species. Three of these unusual voices were carefully traced until the frog responsible for the song was definitely located. In each case it proved to be the ordinary form."

*Breeding habits:* Gloyd (1928) reports the earliest date of singing as April 9 (Franklin county, Kansas). In 1927 he reported (1932) that they were at the height of their breeding activities on April 26. Near Lawrence they were first heard in 1933 on April 28. From these data it would seem that the breeding season is at least a month and a half long over various years, being probably shorter during a single year. This is somewhat different from the dates of activity in northeastern states. Babcock (1926) re-

marks that the average first appearance is on April 28. Wright (1914) records April 19 as the date of first singing (Ithaca).

Wright (1914) states that "The period of ovulation may last a month or more. Generally 20 to 35 days intervene between first appearance and first eggs, and 10 to 15 days between first arrival of species at a pond and first eggs." The eggs are laid in packets, the females laying them at the rate of about one every minute. The process extends over an hour or so.

A typical chorus is described by Gloyd (1932, p. 398):

When we reached the spot, we found ourselves in the midst of an amazing aggregation of breeding tree frogs concentrated in a small area to all appearances no different from any other acre of woodish swamp nearby. The water among the large trees ranged from between six inches and two feet in depth, probably much deeper than usual, since there was evidence of recent heavy rains and flooding from the river. There was practically no undergrowth of small trees or shrublike plants, but fallen trees and brushwood from dead branches were plentiful in the water.

It was impossible to estimate the number of singing individuals with any approach to accuracy, but it was very large. The noise from the undiminished chorus was deafening and single cries, even from individuals only a few feet distant from us, were practically indistinguishable. Our communications to each other had to be shouted although we were almost close enough together to touch hands.

Singing males seemed to be taking advantage of any convenient location, calling from the water, from the tops of wet logs, from perches in partly submerged fallen branches, and from bases of tree trunks a few inches above the water. Wherever our lights turned, from two to fifteen individuals were visible within their range. Females were less conspicuous, but they seemed to occur in each of the localities mentioned. Numerous mating pairs were found in the water and now and then a male embracing a female was carried by her from the water to a floating stick or fallen log. Our presence produced no disturbance of their activities and nothing seemed to be capable of reducing the vigor of their cries. Singing males picked up and allowed to sit in the palms of the hands continued calling with unabated zeal. Their notes were repeated with greater energy and at more rapid intervals than those of the frogs singing at the edge of the open lake earlier in the evening.

Amplexation, as in other hylids, is axillary.

**Development:** Hatching of the eggs takes place 4 or 5 days after laying. About 50-60 days are necessary for the larvae to transform after the eggs are deposited.

**Food:** Munz (1920) found that the food of *Hyla versicolor* is entirely non-aquatic, both of adults and newly-transformed individuals. This included largely Hemiptera and Hymenoptera.

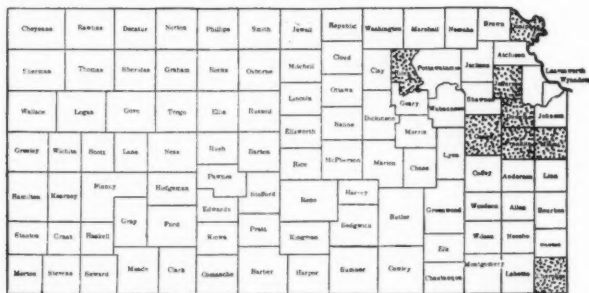
**Habits and habitat:** Dice (1923) records the tree toad from the Aquatic, Shore and Valley forest communities (ecological) of Riley county. From published records and my own observations it may be judged that this frog is more dependent upon an aquatic habitat than many other frogs of this region, as they are frequently found, after emergence, about permanent lakes, swamps or streams—less frequently about the latter. Although they seldom leave the vicinity of these permanent bodies of water, yet they are not actually in the water except during the breeding season, remaining in the trees, shrubs and occasionally on the ground, from where males occasionally call during summer and fall. Prior to the actual breeding season they remain in this terrestrial environment for a few to 10 days, presumably either awaiting suitable temperatures for breeding or actually migrating to the nearest pools.

It is to be expected, then, that they exist in the aquatic communities only during the breeding season, and probably the shore community also, as defined by Dice (1923). At other times they inhabit the Valley forest communities. Dice comments that:

Owing to its proximity to streams a number of the stream border animals wander out into this habitat. With the exception of the presence of these species and the absence of the more characteristic prairie and rocky-slope species, the forests of the valleys contain an assemblage of vertebrates little different from that of the drier woods on the slopes of the hills.

Pope (1919) states that he has kept these alive in captivity for seven years.

**Distribution:** "Maine, southern Canada, west to Minnesota, south to the Gulf States (Texas and Arkansas in part only)." (Stejneger and Barbour, 1923). A number of more recent authors have reported it from Oklahoma (Ortenburger, 1926; Force, 1930) and Kansas.



Map 18. Distribution of *Hyla versicolor versicolor* (Le Conte).

**KANSAS:** Probably over the entire eastern third of the state. Actual records are as follows:

**CHEROKEE COUNTY:** Shoal Creek (KU 10705). **DONIPHAN COUNTY:** (Linsdale, 1927). **DOUGLAS COUNTY:** Lawrence (KU 8124-8125, 8122, 8126); Stubbs Pond (KU 7338-7339); 7½ mi. SW of Lawrence (KU 10717); Haskell Bottoms (KU 16294); Swamp 1 mi. NW of Lakeview (KU 16371-16382). **FRANKLIN COUNTY:** (Gloyd, 1928; OU 888-909; UMMZ 66869(2); USNM, 2 spec.). **JEFFERSON COUNTY:** 3½ mi. NW of Midland (KU, 1 spec.). **MIAMI COUNTY:** Pigeon Lake (Gloyd, 1932; OU 930-947, 974-980, 982; USNM, 2 spec.). **OSAGE COUNTY:** Carbondale (KU, 2 spec.). **RILEY COUNTY:** (Dice, 1923; Burt, 1927; Burt, 1928; USNM, 1 spec.).

**History:** Until 1923 there was no definite locality record of this species in Kansas. Both Cragin (1883) and Hartman (1906) mentioned it, but without giving definite localities. In 1923 Dice recorded it from Riley county, and Burt also in 1927. Burt's *phaeocrypta* of 1928 (Riley county) is also of this species. Linsdale reported it in 1927 from Doniphan county, Gloyd in 1928 from Franklin county, and in 1932 from Miami county.

**Remarks:** The writer has accepted Viosca's opinion (1928) that *phaeocrypta* is no more than *versicolor*, as Viosca examined the type of this species

and found it to be within the range of variation of *phaeocrypta*. If it were not for the fact that the characters which previous authors have used for diagnosis of this species are hardly to be found in preserved material (i. e., the bird-like voice and green color of the concealed surfaces of the femora and groin), and that Burt (1928) mentioned and evidently observed neither, the species might be accepted for Kansas. Further, Burt (*op. cit.*) states that "It differs from any that had been taken in the region and in life somewhat resembled *Hyla crucifer* because its irregular and asymmetrical dorsal markings tended to form a cruciform pattern." This color pattern is distinctly different from what was supposed to be characteristic of *phaeocrypta* (Viosca, 1923; Cope, 1889), but is well within the range of variation of *versicolor*, although perhaps no others of the type had been collected in Riley county. The species upon which Viosca (1923) once based his verification of the existence of *phaeocrypta* has since been described as a new species (*Hyla avivoca* Viosca, 1928), having been compared by the author with the types of the former. Harper (1933) suggests that the records of *phaeocrypta* from Kansas is in reality of *avivoca*. It is evident that this is unlikely.

Whatever be the actual status of *phaeocrypta*, it is the opinion of the writer that since no critical observations were made in life of the specimen in question, and since the description of the pattern (the specimen is now badly faded so that no markings are distinguishable) depict the reverse of the conditions in the supposed *phaeocrypta*, it must be considered as *versicolor*.

#### *Rana areolata* Baird and Girard

##### NORTHERN GOPHER FROG

*Rana areolata* Baird and Girard (1854, p. 173).

Cope (1889, pp. 409-416).

Hurter (1911, pp. 115-117). Notes on habits.

Dickerson (1913, pp. 192-193, pl. 73).

Thompson (1915, pp. 1-7, pls. 1-3). Habits.

Boulenger (*part.*) (1920, pp. 465-468).

Wright and Myers (1927, pp. 173-175).

Gloyd (1928, pp. 117-118). Recorded from Franklin county, with excellent notes on habits.

Force (1928, p. 79). Reported from Oklahoma for the first time.

Wright (1931, p. 351). Discussion of relationships.

*Rana areolata circulosa* Hartman (1906, pp. 228-229). Recorded for the first time from Kansas (Douglas county). Brief notes on food.

*Type locality:* Indianola, Texas.

*Diagnosis:* A rather large *Rana*, tips of toes pointed or slightly swollen; dorso-lateral fold usually broad, distinct, extending to groin; tympanum distinct, with a median clear light blotch; vomerine teeth between choanae; male with large external vocal sacs; longitudinal folds present between dorso-lateral folds, skin on sides smoothly warty; numerous more or less wounded, distinctly outlined, light-edged dark blue, blue-brown or brownish spots on back, hind limbs distinctly banded.

*Comparisons:* *Rana areolata* differs from the *Bufos* of Kansas in the absence of distinct parotid glands and cranial crests; from the *Hylids* by the absence of digital disks and intercalary cartilages in phalanges and the pres-



ence of dorso-lateral folds; from *Gastrophryne* in the presence of a broad head and webs between toes; from *Scaphiopus* in the possession of a round, not vertical pupil, and absence of an outer metatarsal tubercle with a free cutting edge. From *Rana clamitans* and *catesbeiana* it differs in the presence of dorso-lateral folds which extend to the pelvic region; from *pipiens* and *palustris* in general coloration and usually in the extremely broad head.

*Description:* Head broad, plane, rounded and elliptical in dorsal profile; snout long, protruding slightly beyond lower jaw; angle of jaws extending to below middle of tympanum, separated from it by about  $1/3$  the diameter of the latter; tympanum round, bordered above by a groove extending from posterior margin of eye to above axilla, a fold of skin frequently overlapping; eye separated from tympanum by about  $1/2$  the diameter of the latter, which is about  $2/3$  the diameter of the eye; nares somewhat nearer snout than orbits, separated from latter by about the same as the distance between their median borders; tongue long, oval, attached by anterior two-thirds, notched behind; vomerine teeth in two oval patches between or parallel with posterior borders of internal nares, nearer each other than nares, almost in contact; internal nares moderate, posterior to external nares, their inner margins about as far apart as external nares; a fold across chest between axillae; skin of body extending out but slightly on humerus; subarticular tubercles of hand conspicuous, fingers pointed, approximately 5-3-2-4 in order of increasing length (male), toes 1-2-4-3-5; no distinctly visible metacarpal tubercles; fingers not webbed, toes webbed about to antepenultimate phalanx of 4th, penultimate of 3rd and 5th, ultimate of 1st and 2nd; tibio-tarsal articulations overlapping as femora are at right angles to body and legs flexed, extending forward to orbits; subarticular tubercles of foot distinct; inner metatarsal tubercle rather small, about  $1/4$  length of first toe; a rather indistinct tarsal fold; outer metatarsal tubercle small, indistinct or absent; dorso-lateral folds present, with short longitudinal folds between; numerous elongated, smooth warts on each side below dorso-lateral folds; ventral surfaces of body and limbs smooth, except femora and posterior part of belly, which are slightly granular.

Color light slate or light brown above, with numerous dark bluish, blue-brown or darker brown, more or less rounded, usually light-edged, sometimes light-centered, spots over body and head, smaller on latter; posterior limbs with about four cross-bands of a similar color, fore limbs blotched. Dickerson (1913, p. 192) states that the spots may be arranged in four rows between the dorso-lateral folds, and that the light borders of the spots are yellowish white when present; that the concealed surfaces of the femora and groin are yellowish. In some well-preserved specimens the anterior part of the dorso-lateral folds and the supra-axillary region are reddish-yellow. Ventral surfaces immaculate, whitish.

*Variation:* A number of descriptions of *areolata* indicate that the specimens are normally brownish in life. Recently preserved specimens and the many live ones I have observed are not, while specimens long preserved in formalin or alcohol do become quite brownish.

*Sexual dimorphism:* Males possess external vocal sacs, one on each side of the body posterior to the angles of the jaws, extending from the latter to

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above the axillae. The thumbs of males are distinctly enlarged. There is apparently no difference between males and females in the size of the tympanum. Females become slightly larger.

TABLE 21.  
Measurements of adults

	1	2	3	4	5	6
Body length	90.5	41.0	100.0	101.5	93.0	102.0
Width of head	37.5	10.0	35.7	36.0	30.5	37.0
Length of head	26.0	10.0	28.0	28.0	27.0	29.5
Fore leg	53.0	23.8	50.0	54.0	46.0	45.0
Hand	18.1	8.0	17.0	18.0	17.2	18.0
Femur	40.0	16.0	37.0	37.0	31.0	39.0
Tibia	42.5	20.2	40.2	42.0	38.1	41.0
Tarsus	23.0	10.5	22.0	22.5	20.0	23.0
Whole foot	65.0	31.5	63.0	64.0	59.0	63.0

No. 1 is from Anderson county, (KU 9275); no. 2 is from Oswego, Labette county, (KU 8146); no. 3, Lawrence, Douglas county, (KU 9277); nos. 4-6, Lawrence, Haskell Meadows, Douglas county, (KU 7249-7250, 7252).

*Larvae:* The fully developed larvae are not known. At hatching they are 6.5 mm. long.

*Description of eggs:* Laid in large plinth-like masses about 5-6 inches in diameter in shallow water about stems of grass, etc. Probably about 7,000 eggs are in each mass. Individual eggs are rather distinct. The outer membrane measures about 4.5-5.0 mm. in diameter, the inner about 3.15, and the vitellus about 2.46-2.50. The vitellus is considerably larger than in *pipiens*, and the space between the inner and outer membrane is greater than in the latter species.

*Song:* Gloyd (1928, p. 118) remarks that:

The song of *Rana areolata* was most often heard after dark although on one occasion several were singing and splashing in a roadside pond about an hour before sundown. The voice of these frogs does not have the prolonged resonance of that of the bullfrog, *R. catesbeiana*, although it is almost as deep and seems to have even more carrying power. The song most frequently heard is a low-pitched, drawn-out guttural note which may be suggested by the syllables "wurr-r-r-up" (1-2 seconds long) accented on the last. It is repeated several times, either from the surface of the water or from the shore, at more or less regular intervals, varying in frequency. The vocal sacs of the males are lateral and relatively much larger than those of *Rana pipiens*. When singing they are distended until they resemble miniature balloons, each one almost as large as the head itself.

The carrying power is rather great, in my experience. In Cherokee county I heard them singing at great distances from the road, estimated at a mile or so. At that time (April 2) they were singing in large choruses in numerous localities over the county, apparently being very common.

*Breeding habits:* I have found these frogs singing in numerous choruses during the last of March and first of April in southeastern Kansas. Near Lawrence they were collected while breeding on April 27, 1931. In 1933 mated pairs were collected at the same locality on April 21. Gloyd (1928) states that they were last heard singing in 1927 in Franklin county on April 9; the first specimens were taken March 11. The breeding season may then be stated to extend between March 15 to May 15—a two months range.

Temporary pools by roadsides and in pastures are chosen in which to breed and lay eggs. Males sing at the edge of the pools or out in the water, and, although they cease singing frequently upon the approach of a light, yet they will remain above water until splashing about or other noises cause them to duck beneath the water or to sidle back into their holes. In some pools it frequently was possible to capture them after they disappeared by passing the hands back and forth over the mud and grass at the bottoms of the pools, where they remain hidden until further disturbed or danger is past. A number of specimens placed in a tank with three or four inches of water illustrate well this protective instinct. Upon being startled by some sudden activity outside, they duck to the bottom of the water, close their eyes, push their heads down against the bottom of the tank, and propel themselves blindly forward by slow alternate or coincident strokes of the hind legs, holding the front legs against the body. Such actions in pools on soft earth would very quickly cover them from sight.

Gloyd (1928) describes some of the activities during the breeding season as follows:

During the height of the breeding activities the song of the male was varied considerably from what has just been described. On a few occasions, once in daylight about 6:30 p. m., and at other times between dark and midnight, two or three males were observed with vocal sacs and belly inflated, bobbing up and down and splashing about on the surface of the water, accompanying these performances by much chuckling and croaking very unlike their usual song. They floated on the surface, paddling about with their hind feet, their short legs seemingly held rigid with knee joints slightly flexed. Occasionally one would make a rush at another which would evade the plunge by deflating itself and making a sudden dive beneath the surface of the shallow water, immediately coming up only a few inches away and again participating in the same behavior. The actions although indulged in by males only did not seem to have the nature of a combat, but rather a friendly game of sport. At these times females apparently in the role of spectators were seen at the edge of the water or higher on the bank of the pool.

Amplexation, as in the remainder of the Kansas Ranas, is pectoral.

*Development:* No specific observations have been made in this respect of *areolata*. Presumably the tadpoles transform during the first year, passing the winter as newly transformed young.

*Food:* Thompson (1915) states that the stomach contents of several specimens indicated a diet of terrestrial, nocturnal arthropods, largely beetles (most of these Carabidae) and to a lesser extent, spiders. Hartman (1908) found that one fed upon crayfish. The latter might be expected, as they live in environments which bring them into contact with crayfish constantly, yet this seems to be the only record of the latter serving as food.

*Habits and habitat:* The habitat is, in general, low meadowland, which is sufficiently moist to harbor crayfishes. The burrows of the latter are necessary, apparently, for the well-being of this frog, which lives in them during the day, apparently going not far from them at night or at any other time except during the breeding season, when they congregate in considerable numbers in pools and are more gregarious and less wary than at any other time. These burrows are 3-5 feet deep and, at least when inhabited by frogs, a plat-

form of smooth earth is situated in front of each. Holes with funnels, of course, can be inhabited by nothing but crayfish, but frequently or usually they have nothing but the smooth platform in front—always in this case they are inhabited by frogs. These platforms serve to prevent grass from growing at the entrance and provide mounds upon which the frogs sit at night or early in the morning to catch stray insects. In certain other respects, however, the holes inhabited by crayfish differ from those inhabited by frogs, as Thompson (1915, p. 4) remarks:

After excavating for some distance we were able to determine holes occupied by frogs by the slightly smoother appearance of the walls and by the presence of beetle fragments adhering to them. At the bottom of the frog burrows, which usually terminated at a distance of about three feet, was a mass of foul smelling clayey material containing quantities of beetle remains and considerable dead grass, the latter probably having been washed in or accidentally carried down by the frog.

The crayfish in keeping their holes free from debris and open to the water level roughen the walls in the journeys to and from the surface. The frogs of course do not clean their burrows and so the latter tend to fill with soil washed in by the heavy rains. The frogs so nearly approximate the size of the holes that the rubbing of their soft bodies probably tends to smooth the walls, and the longer a burrow has been occupied by a frog the more shallow it becomes by reason of accumulated debris and the less liable it is to contain water. During the spring months, however, the water stands at the very surface of the ground and all of the holes are practically filled at that time.

Both Hurter (1911) and Thompson (1915) remark that the frogs' activities so far as food is concerned must be largely confined to very early morning, as they are rarely seen during the light hours and hardly more at night. This apparently very short time of activity may be due to the fact that the frogs are very wary, and, since they usually remain about their holes, they immediately descend into them and are hidden from sight.

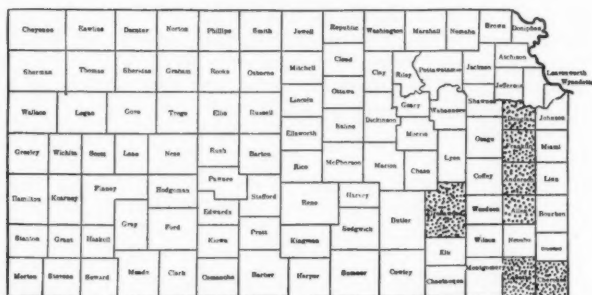
When one attempts to dig them out, they descend farther into the holes, but even then do not generally go to the bottom. We found it difficult to capture them without enlarging the holes, the exceptionally powerful hind limbs and the extent to which they can distend the body serving to secure them so firmly that they could be mutilated before being dislodged. Even when water or thin plaster was poured into the holes the frogs remained to drown rather than to come to the surface. (Thompson, 1915, p. 5).

Individuals picked up in the hands often respond with the peculiar defensive attitude of enormous distention and lowering of head that serves them in their holes.

It is quite likely that their crayfish dwellings suffice for hibernation, although such is not definitely known.

When sitting undisturbed these frogs more nearly resemble bull frogs than leopard frogs, to which they are most closely related, because of the loose and weak articulation in the pre-sacral region which causes the end of the sacrum to project conspicuously from the middle of the back as in *catesbeiana*.

*Distribution:* "Georgia, Texas, Missouri, Indiana and Illinois." (Stejneger and Barbour, 1923). Force (1928, p. 79) has reported it from Tulsa county, Oklahoma, and a specimen from Lewisville, Lafayette county, Arkansas, is in the KU collection (KU 9278).



Map 19. Distribution of *Rana areolata* Baird and Girard.

KANSAS: Probably over the entire southern and central part of the eastern fifth of Kansas. Actual records are as follows:

ALLEN COUNTY: (KU 7155). ANDERSON COUNTY: (KU 9275). CHEROKEE COUNTY: 2 mi. W. of Galena (KU 16161-16198). DOUGLAS COUNTY: (KU 3464, 14054, 14056-14062, 9276); 1 mi. S. of Lawrence (KU 11332-11338; EHT, 18 spec.); Haskell Bottoms (KU 7249-7251, 16329-16342); Lawrence (KU 9277); 2 mi. S. of Lawrence (KU 11713-11716); Wakarusa Bottoms (Hartman, 1906). FRANKLIN COUNTY: (Gloyd, 1928; OU 364-731, 866-872, 876, 878-887; UMMZ 66843-66852, 68411(3), 68412(2), 1 spec.; MVZ, 2 spec.); Ottawa (USNM 89031). GREENWOOD COUNTY: 10½ mi. SW of Toronto (KU 16321-16322). LABETTE COUNTY: 3 mi. E. of Parsons (CEB); Oswego (KU 8146).

*History:* This species has been reported but twice before in Kansas—by Hartman in 1906 from Douglas county, and by Gloyd in 1928 from Franklin county.

### *Rana catesbeiana* Shaw

#### BULLFROG

*Rana catesbeiana* Shaw (1802, p. 106, pl. 33).

- Wright (1914, pp. 77-86). Complete discussion of life history.
- Munz (1920, pp. 38-39, 52-55). Food of larvae, recently transformed individuals.
- Wright (1920, pp. 1-40). A summary of life history, habits, etc.
- McAtee (1921, pp. 39-40). Habits.
- Force (1925, pp. 25-26). Food.
- Babcock (1926, pp. 11-14).
- Burt (1927, p. 3). Reported from Riley county.
- Heller (1927, p. 116).
- Linsdale (1927, p. 77). Recorded from Doniphan county; notes on habits.
- Gloyd (1928, pp. 118-119). A few notes on habits; reported from Franklin county.
- Slevin (1928, pp. 142-144). A rather full bibliography.
- Burt and Burt (1929b, p. 433). Recorded from Washington and Wilson counties, Kansas.
- Burt and Burt (1929c, p. 457). Recorded from Washington county.
- Mohr (1929, p. 94).
- Burt (1931a, p. 5).
- Tanner (1931, p. 195).

- Allen (1932, p. 9). Notes on habits.  
Gloyd (1932, p. 399). Recorded from Miami county.  
*Rana catesbiana* Cragin (1881, pp. 118). Recorded from Shawnee and Riley counties. First definite locality records within the state.  
Cope (1889, pp. 424-428). Description.  
Hartman (1906, p. 228). Food.  
Dickerson (1913, pp. 227-240). An extremely interesting discussion of habits.  
Overton (1914, pp. 38-39).  
Boulenger (1920, pp. 418-420).  
*Rana pipiens* (nec Schreber) Hallowell (1857a, p. 251).

*Type locality:* South Carolina.

*Diagnosis:* Dorsolateral folds absent; vomerine teeth between or on a level with posterior borders of choanae; second finger longer or as long as third; toes pointed or with tips but slightly expanded; color above green or olive, sometimes brownish, usually uniform, but sometimes blotched with darker; venter white, marbled with blackish; young and larger larvae with minute black dots over dorsum.

*Comparisons:* The bull frog differs from all other *Ranas* of Kansas in the absence of dorsolateral folds. From other Kansas salientia it differs as *areolata* (see Comparisons under the latter). There are four other frogs in the United States which do not have dorsolateral folds: *Rana grylio*, *septentrionalis*, *tarahumarae*, *boylei* (and its subspecies) and *heckschleri*. The tympanum of *boylei* is indistinct; the tips of the toes of *tarahumarae* and *boylei* end in small discs (Boulenger, 1920, p. 417); the second finger is shorter than the third in *grylio*; the vomerine teeth are on a level with or just behind the choanae and the first and second fingers are equal in *septentrionalis* (Boulenger, 1920, p. 415); and in *heckschleri* the venter is dark, with light scattered spots (Wright, 1924).

*Description:* Head large, top sloping, pointed and elliptical in dorsal profile; snout pointed and extending forward of lower jaw in lateral profile; lores flat, very angular; a sharp depression posterior to and slightly below naris; latter about equidistant from tip of snout and eye; internarial distance slightly greater than interorbital; diameter of orbits about  $1/5 - 1/6$  greater than distance between inner margins of nares; tympanum distinct, round to slightly oval; a distinct groove from posterior margins of eyes to above insertion of foreleg, partially in contact with tympanum, bordered above by a fold of skin; tongue large, approximately oval, deeply and broadly notched behind; choanae in two oval patches placed diagonally, the median ends caudad, between the choanae; latter rather small, posterior to and considerably farther apart than external nares; skin of body not extending out on humerus; fingers not webbed, about 5-3-2-4 in order of increasing length, toes 1-2-5-3-4; subarticular tubercles of both foot and hand distinct, no distinct metacarpal tubercles; inner metacarpal tubercle moderate, outer edge free; toes fully webbed, the terminal phalanx of the fourth toe sometimes partially free; a flap of skin on the inner and outer sides of the first and fifth toes, respectively; outer metatarsal tubercle absent; tarsal fold present but weak; tibiotarsal articulation not in contact as legs are flexed and femora held at right



angles to body, extending forward to orbit; skin smooth or very slightly warty.

Color above green or olive to brownish, either uniform or indistinctly blotched with darker; hind legs usually indistinctly banded or spotted; if the latter, spots arranged in transverse rows; venter immaculate and whitish, or obscurely mottled with darker, especially about chest and in gular region, concealed surfaces of tibiae and femora heavily mottled or reticulated. Young and larvae with minute black specks above.

*Sexual dimorphism:* In males the "thumb" is slightly enlarged, and, according to Dickerson (1913), the color is usually greenish or olive, females being brownish. There is a marked difference in the size of the tympanum, which in males is almost twice the internarial distance, but only slightly greater in females.

TABLE 22  
Measurements of adults

	1	2	3	4	5	6	7	8	9	10
Body length	137.0	75.4	134.0	152.0	99.0	115.0	112.3	112.0	86.0	73.0
Width of head	52.4	28.5	55.5	60.0	37.0	42.0	37.0	42.5	34.0	29.0
Fore leg	76.0	47.5	75.0	89.5	56.0	60.0	51.0	58.0	47.0	38.0
Hand	26.0	15.0	21.0	27.8	22.0	24.0	22.0	22.0	16.5	14.0
Femur	57.0	31.0	57.0	64.0	44.0	45.0	43.0	49.0	37.0	30.0
Tibia	51.6	33.0	54.0	61.0	45.0	50.0	47.0	51.0	38.0	29.0
Tarsus	30.0	16.0	31.0	35.0	20.0	24.0	22.0	24.0	18.0	8.5
Whole foot	92.5	54.0	94.6	102.0	68.0	77.5	74.0	76.9	59.4	49.0

No. 1 is from Talmage, Dickinson county, (KU 8619); no. 2 is from Gove county (KU 8636); nos. 3-4 are from Apponoose Creek, Douglas county (KU 8689-8690); nos. 5-7 are from Manhattan, (KSC 91-93); nos. 8-10 are from Marshall county, (KSC 88-90).

*Larvae:* Described in detail by Wright (1914, pp. 83-84; 1929, pp. 37-38, pl. 8, figs. 7-9).

*Eggs:* Usually laid in large films on the surface of the water, varying in size from 3 to 5 square feet. The egg complement of a single female, and of the mass of eggs, is about 10-20,000. The individual eggs are usually not distinguishable in the mass of jelly; a single membrane may be visible, about 6.4 to 10.4 mm. in diameter. The vitellus is about 1.2 to 1.4 mm. in diameter. They are laid in packets which fuse to form the whole film.

*Song:* A deep bass booming of great carrying power, which may be expressed "be drowned," "br-wum," or, according to some, by "jug-o-rum," "bottle-o-rum," "more rum," etc. They have been heard in Kansas as early as March 24 (Gloyd, 1932), and continue at least into the middle of June. Wright (1914) states that at Ithaca they sing as late as the middle of July, although they do not begin until about the middle of May. When singing enthusiastically they call about three to four times in about twice as many seconds, are silent for about five minutes, and then repeat. They frequently choose particular stations from which to call, and retain them for considerable periods of time from various intruders.

That the call has a musical quality was once illustrated most ludicrously. During

the rehearsal of a chorus of female voices, a big yellow-throated bullfrog, in an adjoining room, began vigorously ejaculating, "Jug-o-rum, jug-o-rum, jug-o-rum." Several persons were deceived for the moment into thinking that the bass voice of the director had joined the chorus, for it happened that first few notes of the frog were in time and harmony with the chords of the selection. A tame bullfrog will always sing when other sounds are being produced, whether these are musical or not. He always becomes enthusiastic at the sound of running water. (Dickerson, 1913, pp. 232-233).

*Breeding habits:* At Ithaca the bullfrog is the latest of the amphibians there to breed (Wright, 1914). Babcock (1926) places them after all other salientia of New England in time of emergence. This is more or less the case in Kansas. Gloyd (1928) reported them as early as February 16, although it was not until late March and early April that adults were seen frequently. Observations have not been sufficient to state definitely the limits of the breeding season in this region. Eggs are usually laid at one place, the females rarely moving about in the process.

Amplexation is axillary or pectoral.

*Development:* Hatching of the eggs takes place usually 4-5 days after laying, or sometimes less, according to temperatures. The larvae spend two years in the larval stage, transforming late in the second summer after hatching. Recently transformed, presumably of the third year, individuals are common and even numerous about pools early in the spring—much earlier than the adults appear.

*Food:* Munz (1920) has studied the food of this species in detail. His results indicate that somewhat over half the food is non-aquatic, the remainder being doubtful or aquatic. Force's (1925) investigations agree with this in general. In a frog supposedly about as nearly aquatic as any in the United States, this diet is rather surprising, as a greater percentage of aquatic food would be expected. Even so, the percentage of aquatic forms probably is greater than in any other species. Many forms other than insects are occasionally eaten. Hartman (1906) records one which contained a sparrow; McAtee (1927) states that one became accustomed to eating ducklings; Heller records a Brewer's mole in the stomach of another; Hay (1892, p. 479) remarks that some have eaten snakes, a "cedar-bird," mice, etc.; a specimen in Kansas University contains a moderate-sized leopard frog; a Kansas newspaper recently reported that a bullfrog in one of the state schools swallowed a young alligator, which was, however, not retained; and Dr. R. H. Painter of Kansas State College relates in good faith an experience in which a small snake was observed to crawl out of the anus of a bull-frog which had just been shot, and which presumably had swallowed the snake but shortly before.

*Habits and habitat:* The bull-frog is typically solitary and limited in ecological distribution to permanent aquatic residences, such as lakes, rivers, streams, and permanent ponds. They do not ordinarily breed in and sing from temporary pools and shallow streams as do many other frogs of this region.

McAtee (1921) reports that this frog at times demonstrates the possession of a marked homing instinct, returning to the usual station after having been removed from it considerable distances.

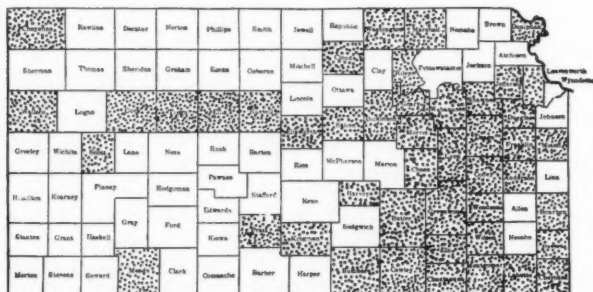
The period of hibernation is probably spent under water. Mohr (1929) records having taken them from the bottoms of deep springs in winter, where they were buried in the muck.

Albinos have been reported by Burt (1931a).

An unusual activity of the tadpoles was noticed by Linsdale (1927, pp. 77):

On January 22, 1924, hundreds of tadpoles of this species were swimming at the surface of holes where the ice had been removed from the center of the lake. This was the most active creature in the water at that time.

**Distribution:** "North America east of Rocky Mts. except extreme south-east and Gulf State coastal plain. . ." (Stejneger and Barbour, 1933). Part of this distribution is due to artificial introduction; Ellis and Henderson (1915) state that such were the means of its introduction into Colorado. West of the Rocky Mountains Storer (1925) has recently reported it from California, and Tanner (1931) from Utah.



Map 20. Distribution of *Rana catesbeiana* Shaw.

**KANSAS:** Probably state-wide except south-western region. Rather discontinuous due to introduction. Actual records are as follows:

**ANDERSON COUNTY:** (KU 1942, 5027, 7135-7136). **BOURBON COUNTY:** (UMMZ 66840, 66842, 66838). **BUTLER COUNTY:** Beaumont (KU 9211-9244, 8603, 8511-8612). **CHASE COUNTY:** 5 mi. N. of Saffordville (KU, 1 spec.). **CHAUTAUQUA COUNTY:** Camp Ta-la-hi, 4 mi. SE of Cedarvale (CEB). **CHEROKEE COUNTY:** 3½ mi. W of Baxter Springs (CEB); ½ mi. N of Cravensville (CEB); Spring Hill River (KU 8604, 8641). **CHEYENNE COUNTY:** Eastern outskirts of St. Francis (CEB). **CLOUD COUNTY:** (KU, 9 spec. Tadpoles). **COFFEY COUNTY:** 5 mi. SE of Strawn (KU 8674). **COWLEY COUNTY:** Arkansas City (KU 9098-9099); Winfield City Park (CEB); 1½ mi. N of Winfield (CEB); 6 mi. NE of Winfield (CEB); Southwestern College Campus (CEB); Timber Creek, 4 mi. NE of Winfield (CEB); 7 mi. SE of Winfield (CEB). **CRAWFORD COUNTY:** Along Cow Creek, Pittsburgh (KU 9644). **DICKINSON COUNTY:** Talmage (KU 8619). **DONIPHAN COUNTY:** (Linsdale, 1927); Doniphan Lake (KU 8609-8610, 8613-8615). **DOUGLAS COUNTY:** (KU 8662, 8642, 8672, 8628, 8629, 8615, 2665, 7137, 8639-8640); Apponoose Creek (KU 8689-8690, 8605); Haskell Meadows (KU 7647, 7691, 9155); Lawrence (KU 8668, 8624); 4 mi. N of Lawrence (KU 8625-8627); Mt. Oread, Lawrence (KU 86043); ¾ mi. W of KU Campus in rock quarry (KU 9156-9157);

Rock Creek (KU 8684-8685; USNM 51616-51620). ELLIS COUNTY: (L. A. Brennan, MS; HMS, 1 spec.). ELLSWORTH COUNTY: (HKG 2106-2107). ELK COUNTY: Paw Paw Creek (KU 8665-8666, 8618); Elk River (KU 8616, 8617, 8606). FRANKLIN COUNTY: (Gloyd, 1928; OU 372-375, 779-785, 820-821); Ottawa (KU 9150-9151). GEARY COUNTY: Fort Riley (USNM 3329). GOVE COUNTY: (KU 8636). GREENWOOD COUNTY: (KU 8686); Salt Creek (KU 8687-8688, 8599-8602, 8620, 8597-8598, 8621, 8607, 8608); South of Railroad in pond east of Falls River (KU 8623). HARVEY COUNTY: 5 mi. SW of Walton (KU, 1 spec.). JEFFERSON COUNTY: 2 mi. N. of Lawrence (KU 8671, 8675-8676). KINGMAN COUNTY: Outskirts of Kingman (KU, 1 spec.). LABETTE COUNTY: Big Hill Creek, Sumner (KU 8673, 9168); Montana; shallow roadside ditch near garden and above culvert; woods near; (CEB); 3 mi. E of Parsons (CEB); pasture ponds in open prairie area. LEAVENWORTH COUNTY: State Lake near Tonganoxie (HMS). LYON COUNTY: 15 mi. SW of Emporia (CEB). MARSHALL COUNTY: Elm Creek, Blue Rapids (KU 8667, 8658-8659; KSC 88-90). MEADE COUNTY: State Lake\* (HMS). MIAMI COUNTY: Pigeon Lake (Gloyd, 1932; UMMZ 66831-66837; 66839; 66841; OU 822-823); Middle Creek (KU 8678, 8634-8635). MONTGOMERY COUNTY: Drum Creek (KU 8679-8683); Independence (KU 9186-9193). MORRIS COUNTY: 7 mi. NE of Council Grove (KU, 1 spec.). OSAGE COUNTY: Quenemo (KU 8637). PRATT COUNTY\*\*: (KU 8661, 3500, 3522, 3523-3529). RILEY COUNTY: (Burt, 1927); Manhattan (Cragin, 1881; KSC 87, 91-93; USNM 89032-89034). RUSSELL COUNTY: Marion (KU 8622; HMS, 1 spec.). SALINE COUNTY: Brookville (HMS, 1 spec.). SCOTT COUNTY: State Lake\*\* (HMS). SHAWNEE COUNTY: Topeka (Cragin, 1881). SUMNER COUNTY: 3 mi. E of Kingman-Sumner county line, E of Norwich (KU, 2 spec.). TREGO COUNTY: (HMS, 1 spec.). WAUBANSEE COUNTY: 8 mi. NE of Chalk (KU, 1 spec.). WALLACE COUNTY: (CWH). WASHINGTON COUNTY: Owen (Burt and Burt, 1929b); Nutch's Pond, 2 mi. E of Haddam (Burt and Burt, 1929c, p. 457). WILSON COUNTY: 2 mi. N of Neodesha, Verdigris River (KU 9159-9160); 4 mi. NE of Neodesha (Burt and Burt, 1929b); 1 mi. W of New Albany (KU 9153-9154; CEB). WOODSON COUNTY: Neosho Falls (KU 8660, 9178-9185, 9194-9204, 9206-9208, 9210, 9254-9261).

*History:* It is probable that Hallowell's (1857a) *Rana pipiens* was *Rana catesbeiana*, as he remarks of the difference in size of tympanum (a sexually dimorphic character not found in *pipiens* but normal in *catesbeiana*), of the ventral mottlings (normal in the bullfrog but not in the leopard frog), and of the minute black spots of the young (a very characteristic marking of young bull-frogs). No definite localities were given.

The species was first recorded definitely from the state, and under the correct name, by Cragin in 1881. Although the U. S. National Museum has a specimen from Ft. Riley numbered 3329, which should have been included by Yarrow and Cope, I find no mention of it in the works of either. Cragin reported it from two counties—Riley and Shawnee. His is the only record for the latter. Hartman's incidental reference of this form to Kansas in 1906 is the only additional record until 1927, when Burt reported it from Riley county and Linsdale from Doniphan. Since then Gloyd (1928) reported it from Franklin county, Burt and Burt (1929b, c) from Washington and Wilson counties, and Gloyd (1932) from Miami county. Previous publications have thus recorded the species from seven eastern counties.

\* Probably introduced.

\*\* Introduced.

*Rana clamitans* Latreille

## GREEN FROG

*Rana clamitans* Latreille (1801, p. 157).

Cragin (1881, p. 120).

Dickerson (1913, pp. 198-205).

Deckert (1915, pp. 53-54). Albinos reported.

Boulenger (1920, pp. 425-428).

Munz (1920, pp. 40-42, 52-55). Food.

Wright and Wright (1924, pp. 375-381, fig. 16). Eggs.

Babcock (1926, pp. 11-14).

Pope and Dickinson (1928, pp. 32-38).

Wright (1931, pp. 352-364).

Smith, H. M. (1932, p. 95).

*Rana clamita* Cope (1889, pp. 419-423).

Wright 1914, pp. 71-76).

*Type locality:* Charleston, South Carolina.

*Diagnosis:* A *Rana* with pointed or but slightly expanded tips of toes; dorso-lateral fold extending to sacrum; vocal sacs of males internal; color greenish anteriorly on back, brownish posteriorly; not distinctly spotted; tympanum much larger in males than in females.

*Comparisons:* From other *Ranas* of Kansas, *clamitans* differs in the character of the dorso-lateral folds, which are present but terminate at the anterior end of the sacrum. It resembles, in the absence of distinct and definitely outlined dorsal spots, *Rana catesbeiana* more closely than any other. Since the presence or absence of dorso-lateral folds is sometimes difficult to determine because of improper preservation, it may be well to add that it differs from the latter species also in greater size of the tympanum in males (practically in contact with the orbit), in the overlapping of the tibio-tarsal articulations (separated or barely in contact in *catesbeiana*) and in the lesser extension of the webs on the fourth toe (both ultimate and penultimate free in *clamitans*, only the ultimate, or part of it, in *catesbeiana*). From other anurans of Kansas it differs as *Rana areolata* (see Comparisons under the latter). It is apparently most closely related to *Rana onca* of Utah and Nevada, in which the dorso-lateral folds extend beyond the sacrum, although not to the hind legs.

*Description:* (From a series of males collected at Perryville, Decatur county, Tennessee.) Head rather narrow, pointed, sharply elliptical in dorsal profile; snout slightly pointed in lateral profile; nares about equidistant from orbits and tip of snout; internarial distance nearly twice interorbital distance, about  $3/5$  the longitudinal diameter of orbit; tympanum slightly larger than eye, round, practically in contact with both orbit and angle of jaws; latter below middle of tympanum; lores flat, except for a small concavity between orbits and nares on each side, angular; canthi rather distinct; tongue oval, deeply notched behind, attached by anterior  $2/3$ ; vomerine teeth in two very small patches between choanae, on a level with the posterior margins of the latter, and almost in contact, separated on each side from the internal nares by about twice the diameter of one; choanae farther apart and posterior to external nares; skin of body not extending out on humerus; no

metacarpal tubercles; first subarticular tubercles of hand distinct, the remainder indistinct or absent; fingers not webbed, pointed, usually 2-3-5-4 in order of increasing length, toes 1-2-5-3-4, subarticular tubercles of foot moderately distinct, the first most distinct of all; inner metatarsal tubercle present, with a free outer edge; no outer metatarsal tubercle; tarsal fold low or absent; tibio-tarsal articulations overlapping as femora are at right angles to body, extending forward to orbit or between orbit and end of snout; dorso-lateral fold usually terminating at or before sacrum; a groove circling tympanum from posterior border of orbit to above axilla; a fold of skin above the groove continuing laterally down the body as the dorso-lateral folds, sometimes branching above tympanum and continuing for a varying distance along the posterior margin of the latter; dorsum, except head, which is smooth, with numerous smooth or spinose rugosities, especially laterally; rugosities on hind limbs sometimes arranged in longitudinal rows; venter smooth except in anal region.

Color above (in preservative) uniform olive or olive-brown, sometimes with blackish blotches of indefinite outline scattered over back, sides and top of head, limbs sometimes narrowly banded; posterior surfaces of femora reticulated or heavily marbled with blackish, or almost uniform blackish or gray with minute light spots; gular region sometimes faintly blotched with gray, otherwise white and immaculate. In live specimens "Typically, the coloring is brilliant metallic green on head and shoulders and dusky olive (perhaps spotted) posteriorly. There may be a yellowish band (widening anteriorly) along the lines of the jaw from the shoulder forward. Throat of the male bright orange-yellow; that of the female, white spotted with dark. Sides of body often marked with large blotches of dark. (This is especially true of the female)." (Dickerson, 1913, p. 198)

*Sexual dimorphism:* In females, the tympanum is removed from the orbit and angle of jaws by about  $\frac{1}{2}$  of its diameter and is about  $\frac{1}{3}$  greater than the internarial distance; in males the distance is about twice the diameter of the internarial distance and the tympanum is practically in contact with orbit and angle of jaw. Females may be more smooth-skinned than males. The proximal phalanx of the latter's thumb is distinctly enlarged, conspicuously differentiated from the remainder of the phalanges of the same finger.

TABLE 23  
Measurements of adults

	1	2	3	4	5
Body length	63.0	71.5	88.0	47.0	60.0
Width of head	21.5	26.5	32.0	17.0	20.5
Fore leg	36.9	38.5	44.0	25.2	33.0
Femur	31.8	36.0	40.0	22.0	28.5
Tibia	31.0	36.5	43.0	23.5	29.0
Tarsus	18.0	21.3	23.0	12.5	16.0
Foot	33.2	37.5	42.0	24.0	29.0
Hind leg	102.0	114.0	133.5	70.0	91.0

No. 1 is from Miami county (KU 9281); nos. 2-5 are from Cherokee county (KU 16205, 17473-17475).

*Larvae:* Described in detail by Wright (1914, p. 75; 1931, pp. 361-362).

*Eggs:* Laid as a surface film, as in *R. catesbeiana*, but the film is usually



only one layer deep and not over a foot square, although somewhat larger masses are occasionally laid. The eggs are first laid in packets, which later fuse to form the whole film. Two envelopes are present in each egg, aside from the vitelline membrane, the outer being from 5.6 to 6.0 mm. in diameter, the inner 2.8 to 4.0 mm. (Wright, 1914, p. 74).

*Song:*

F. Harper characterizes the call as follows:

... its twanging bass note is heard at considerable and probably irregular intervals, of, say half a minute or more. Ordinarily a single *clung* or *c'tung* is given; but sometimes there is a rather rapid series of several notes: *clung-clung-clung-clung* or *c'tung*. "The note is not loud nor has it far reaching effect." (Wright, 1931, p. 357). "The explosive character of the sound will be better understood if we watch the frog when he is croaking. He works hard; there is no appearance of external vocal pouches. . . but the yellow throat and the sides expand with such force as to jerk the whole body forward. Slowly the distended parts sink in as the vigorous sounds proceed. Then the throat and side swell out again, and there follows another explosion of sound. (Dickerson, 1913, p. 199).

*Breeding habits:* No observations have been made in Kansas regarding breeding habits. In the New England States (Babcock, 1926) the spring appearance is April 7 on the average. About a month after appearance, they begin singing, and ovulation begins in late spring or early summer. Amplexation is pectoral. Further details are given by Wright (1914, 1931).

*Development:* The eggs hatch, according to Wright (1914, p. 75) in about 3-6 days, and the larvae transform during the second year, or about 370-400 days after hatching.

*Food:* In spite of the rather aquatic habits of this frog, the diet consists, according to Munz (1920) largely (90-91%) of non-aquatic forms. Apparently, strictly terrestrial, i. e., ground, forms (Vermes, Crustacea, Spiders, land Hemiptera, etc.) are preferred or most frequently discovered because of various habits, perhaps nocturnal, of food-getting, although a considerable number of flying forms (Diptera and Hymenoptera) were contained in the stomachs.

*Habits and habitat:* As a rule, *clamitans* is solitary, seldom if ever congregating in large numbers even during the breeding season. In certain parts of Cherokee county they were found in rather peculiar environs. In this region are a large number of abandoned mining pits, some of which are very deep and with nearly vertical sides. Occasional ones are rather shallow, having caved in or been otherwise partly filled. Water collects in them from the periodic showers, and permanent pools are formed. It was only in such pools that these frogs were found. Although not rare, they are so wary and difficult to collect that only by extreme perseverance did we succeed in capturing our specimens. They were not abroad during the day, probably seeking the protection of the leaves and other debris of the pools at such times.

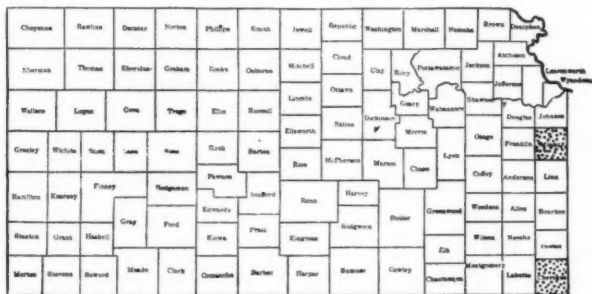
The name "Screaming Frog" has been aptly applied to this frog because of its habits of leaping far up into the air when disturbed and dropping into the water "uttering a short, high-pitched cry," which, according to Dickerson (1914, pp. 198-199), suggests that of a frightened bird.

In restriction to permanent bodies of water, this frog is second probably only to the bullfrog. The temporary pools are insufficient for their needs.

It is probable that the period of hibernation is passed under the water. Allen (1932) states having taken them out of deep springs in January, and Mohr (1929) found them in similar places.

Albinos have been reported from New York by Deckert (1915).

**Distribution:** "Eastern North America, Canada to Florida and Louisiana, west to Michigan, Wisconsin, Minnesota, Illinois, Arkansas, and Texas." (Stejneger and Barbour, 1933) Known also from various localities in Oklahoma (Ortenburger, 1926, 1929a, 1929b) as far west as Lincoln county.



Map 21. Distribution of *Rana clamitans* Latreille.

**KANSAS:** Perhaps over the entire extreme eastern part of the state. Actual records are too few as yet to allow a definite statement of the range in Kansas. They are as follows:

**MIAMI COUNTY:** (Smith, H. M., 1932); Marias des Cygnes River, near Ossawatimie (KU 9281). **CHEROKEE COUNTY:** (Smith, H. M., 1932); Near Riverton (KU 16205, 17473-17475).

### *Rana palustris* Le Conte

#### PICKEREL FROG

*Rana palustris* Le Conte (1825, p. 282).

Cope (1889, pp. 406-409, fig. 102).

Hurter (1911, pp. 117-119).

Dickerson (1906, pp. 188-192). Habits.

Overton (1914, pp. 35-36).

Wright (1914, pp. 61-69). Complete outline of life history, and general discussion.

Boulenger (1920, pp. 444-446). Redescription in detail.

Munz (1920, pp. 44-46, 52-55). Food.

Babcock (1926, pp. 11-14).

Pope and Dickinson (1928, pp. 39-40).

Smith, H. M. (1932, p. 95).

**Type locality:** ?

**Diagnosis:** A *Rana* with pointed toes or with tips but slightly expanded; dorso-lateral folds present, inner folds present also, usually both very broad; vomerine teeth usually between choanae; foot smooth except for subarticular and metatarsal tubercles; pattern of rectangular blotches, usually in two rows

between the dorso-lateral folds, and two on each side; concealed surfaces of femora and groin orange in life.

*Comparisons:* From *Rana catesbeiana* and *clamitans*, this frog differs in the presence of dorso-lateral folds which extend to the hip; from *areolata* and *pipiens* it differs in the presence and regular arrangement of the rectangular spots and in the orange color of the concealed surfaces of the femora and groin. From other Kansas anurans it differs as does *Rana areolata* (See comparisons under the latter).

The closest relative of *palustris* is *pipiens*. No other frogs resemble it in pattern.

*Description:* (Female, St. Clair county, Illinois. KU 7883) Head rather thick, broad, roundly pointed and elliptical in dorsal profile; snout either rounded or truncate in lateral profile; canthus rostralis rather distinct, rounded; lores rounded, angular, an elongated concavity between nares and orbit; tympanum round, sometimes bordered above by a fold of skin and separated from tympanum and angle of jaws by about 1/3 of its own diameter; angle of jaw below middle of tympanum; interorbital distance  $2/3$  to  $1/2$  of internarial distance; latter about equal to orbitonarial distance, about  $2/3$  to  $3/5$  of longitudinal diameter of orbit; tongue rather large, deeply and broadly notched behind; vomerine teeth in two diagonal, oval patches between choanae, a little nearer each other than choanae; skin of body not extending out onto humerus; subarticular tubercles present; fingers 2-3-5-4 in order of increasing length, toes 1-2-5-3-4; fingers not webbed, toes nearly fully webbed but deeply indented, the two terminal phalanges of the fourth toe free or largely so, a narrow flap sometimes bordering each side; subarticular tubercles distinct; inner metatarsal tubercle present, with a free outer edge; outer metatarsal tubercles low, rounded, occasionally absent; tibio-tarsal articulations in contact or overlapping as femora are at right angles to body, and extending forward to orbit or tip of snout; dorso-lateral folds present, broad, extending onto upper eyelids and posteriorly to the insertions of the hind legs; a pair of folds usually present interior to dorso-lateral folds, nearly as broad, and extending from posterior margin of eyelids to sacrum; a second inner pair of folds, somewhat narrower and more closely approximated, extending from sacrum to above anus; a broken fold extending from angle of jaws to above axillae; a few rounded or elongate, smooth warts on sides; ventral surfaces smooth except about anal region and postero-ventral surfaces of femora.

Color above, tan or light brown, with rectangular, definitely outlined, sometimes very narrowly light-bordered dark reddish-brown spots, arranged in two more or less regular rows between the dorso-lateral folds and also in two rows on the sides, the lower row of much smaller spots; fore limbs blotched above, hind limbs rather narrowly banded, the bands varying in number from four to five; dorso-lateral folds sometimes silvery; posterior surfaces of femora blotched; concealed surfaces of femora and groin orange; ventral surfaces immaculate usually, otherwise spotted in the lower labial region.

*Sexual dimorphism:* Males have enlarged thumbs and internal vocal sacs. The tympanum does not vary with sex.

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TABLE 24  
Measurements of adults

Body length	57.0	43.5	71.0	Femur	29.3	21.8	32.0
Length of head	18.0	14.0	18.0	Tibia	32.0	24.5	36.2
Width of head	20.0	15.0	22.0	Tarsus	17.0	12.0	20.0
Fore leg	33.0	27.5	38.5	Foot	29.0	25.5	35.0
Hind leg	95.0	82.0	113.0				

No. 1 is from Crawford county (KU 9488); nos. 2-3, Cherokee county (KU 17470-17471).

*Larvae:* Described by Wright (1914, pp. 67-68) in detail.

*Eggs:* Usually laid in shallow water, sometimes in deeper (1-3 feet), and in globular masses  $3\frac{1}{2}$  to 4 inches in diameter. They are usually on twigs, grass stems, etc., sometimes with several on a single stem. The vegetative pole is bright yellow and the animal pole is brown. Two envelopes, aside from the vitelline membrane, are present. The outer is 3.6 to 5 mm. in diameter, and the inner 2.4 to 2.8. The vitellus is 1.6 to 1.9 mm. in diameter. The egg-complement is about 2,000 to 3,000. (Wright, 1914).

*Song:*

The voice of a pickerel frog is low in pitch, and small in volume. One will not be heard at a distance of many rods, unless the night is extremely still. Few persons would notice the sound at all, unless their attention were called to it. The sound resembles a gently musical snore by a sleeping person. It is unmistakable if its snoring qualities are remembered. Its song lasts about half a minute, and it sings at intervals of about five minutes. (Overton, 1914, p. 36).

Some authors have compared the voice with the tearing of some coarse material.

*Breeding habits:* No observations have been made of the breeding habits of this frog in Kansas. In the New England States it appears first about April 3 (Babcock, 1926). At Ithaca an average of 20 days intervene between first appearance and first matings, and breeding continues for about three weeks. Egg laying ceases by about May 15, after which the frogs repair to meadows and fields, and are seldom seen or heard.

*Development:* The eggs hatch in from 11 to 21 days, and the larvae transform in about 90-100 days after egg-laying, transformation occurring in late July or early August.

*Food:* Munz (1920) found that the food of the recently transformed individuals consisted primarily (76%) of non-aquatic forms, such as spiders, land Hemiptera, Diptera, Coleoptera and Hymenoptera. Adults feed to a somewhat greater extent (95%) upon land forms.

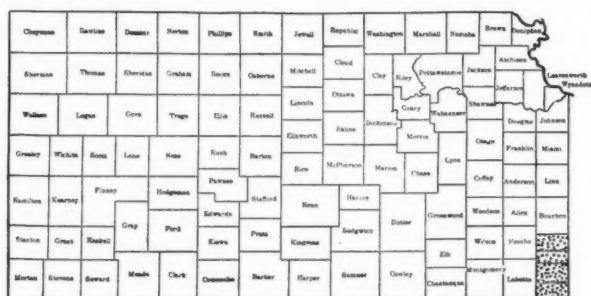
*Habits and habitat:* During the breeding season *palustris* frequents cold springs, permanent, clear streams, ponds, lakes, etc., where there is sufficient vegetation about the water's edge to conceal them. Occasionally they inhabit swamps, but never the temporary, muddy quarters which are most prevalent in central and western Kansas. It is adapted to conditions as found, in Kansas, only in the southeastern part, where myself and others have found them in deep springs, from the bottoms of which they were obtained in nets. *Palustris* is apparently exceptional among *Ranas* of the United States in the

capability of secreting an irritating dermal fluid, of disagreeable odor, which serves well to prevent dogs and the like from eating them. Peculiarly enough, this exceptionally poisonous character (for the *Ranas*) is associated with the orange color quite frequently thus associated in amphibians and other animals.

Hibernation probably takes place under water in deep springs, ponds, and the like.

The name "Pickerel Frog" is derived from the fact (supposed) that in some parts of the United States they are used in fishing for pickerel.

*Distribution*: "Hudson Bay south to Arkansas and Louisiana and all of the eastern states west to Wisconsin;" (Stejneger and Barbour, 1933) Hurter (1911, p. 118) reports the species from various counties well distributed over the state of Missouri.



Map 22. Distribution of *Rana palustris* Le Conte.

**KANSAS:** Known only from the extreme southeastern corner. It may be found somewhat farther north in the state. Actual records:

**CHEROKEE COUNTY:** 3-5 mi. N of Baxter Springs, near Spring River (Smith, H. M., 1932; KU 17470-17471). **CRAWFORD COUNTY:** Along Cow Creek, Pittsburgh (KU 9488).

*Remarks:* The above localities mark at present the western limit of the range of this species. It has not yet been reported from Oklahoma, although it undoubtedly exists there, at least in the northeastern corner.

### *Rana pipiens* Schreber

#### LEOPARD FROG

*Rana pipiens* Schreber (1782, p. 185, pl. 4).

Hay (1892, pp. 473-475). Habits.

Dickerson (1913, pp. 171-185).

Overton 1914, pp. 34-35). Notes on life history and habits.

Wright (1914, pp. 52-60). Life history.

Munz (1920, pp. 46-48, 52-55). Food.

Storer (1925, pp. 266-270).

Burt (1927, p. 3). Recorded from Riley county.

Linsdale (1927, p. 77). Recorded from Doniphan county, with notes on habits.

Gloyd (1928, p. 119). Recorded from Franklin county. Notes on habits.

Rennie, Anna E. and Weese, A. O. (1928, pp. 84-90).

Slevin (1928, pp. 121-125). Rather complete synonymy.

Strecker and Williams (1928, p. 13). Discussion of relationships with *sphenoccephala*.

Burt and Burt (1929b, pp. 433-434). Recorded from Washington, Clay, Marshall, Phillips, Wilson counties, Kansas.

Taylor (1929, p. 65). Recorded from Morton county.

Gloyd (1932, pp. 399-400). Recorded from Miami county, with notes on breeding habits, etc.

*Rana halecina* Hallowell (1857a, pp. 250-251). Kansas and Nebraska.

Cragin (1881, p. 118). Recorded from Kansas, but with no definite locality.

Boulenger (1920, pp. 433-443). Recorded from Douglas county. Discussion of relationships.

*Rana halecina berlandieri* Yarrow (1883, pp. 180-181). Recorded from Salt Creek, Kansas.

*Rana virescens brachycephala* Cope (1869, pp. 403-406, fig. 101).

Hartman (1906, p. 229). Food.

*Rana* sp. Dice (1923, p. 46). "Leopard Frog" recorded from Riley county. Probably *pipiens*.

Type locality: Pennsylvania.

**Diagnosis:** A *Rana* with tips of toes pointed or but slightly expanded; vomerine teeth between or on a level with posterior borders of choanae; dorso-lateral folds present, rather narrow, extending to insertions of hind legs; skin between frequently corrugated; webs extending to penultimate phalanx of fourth toe; male with rudimental external vocal sacs; pattern of a series of rounded spots, sometimes light edged, varying greatly in number from three or four to as many as 25-30; ground color slate.

**Comparisons:** From *Rana catesbeiana* and *clamitans* this frog differs in the continuation of the dorso-lateral folds to the insertion of the hind legs. Color differences distinguish it largely from *areolata* and *palustris*. More complete comparisons are given with each of the latter. From the other Kansas salienta *pipiens* differs as does *areolata* (see Comparisons under the latter).

**Description:** (Largely from a male, KU 9843, from Neosha Falls, Woodson county, Kansas) Head moderately thick, top slightly convex; head somewhat pointed in dorsal profile; snout more or less obliquely truncate in lateral profile, projecting slightly beyond and overlapping the lower jaw; internarial distance  $1/3$  to  $1/4$  less than orbitonarial distance, about  $1/2$  diameter of the orbits; interorbital distance about  $2/3$  of internarial; diameter of tympanum about equal to or a little more than internarial distance, separated by about  $1/4$  of its diameter from orbit, and by about  $1/5$  to  $1/6$  from angle of jaws; a groove from posterior margin of eye above tympanum to above axillae, sometimes bordered above by a fold of skin; lores nearly flat; tongue large, oval, deeply and broadly notched behind; vomerine teeth in two elongate or oval, diagonal series between or at a level with posterior margins of choanae, nearer each other than choanae; a groove across chest between axillae; skin of body not extending out onto humerus; fingers not webbed, 2-3-5-4 in order of increasing length; three metacarpal tubercles usually present, one at base of fifth finger, another at base of third and fourth, and one at base of second; toes nearly or quite fully webbed, except two terminal phalanges of the fourth toe, which are bordered by a narrow flap of skin extending from the web;



subarticular tubercles distinct on both hands and feet; a dorsal groove across toes and fingers between penultimate and ultimate phalanges; tibio-tarsal articulations overlapping, extending forward to eye, tip of snout or beyond; tarsal fold distinct, curving onto posterior surface of tibia; inner metatarsal tubercle rather small, but with a free cutting edge; a flap of skin extending out on the sides of the first and fifth toes; dorso-lateral folds present, originating behind orbits above supra-tympanic groove, and extending to middle of insertion of hind limbs; sometimes a series of corrugations between dorso-lateral folds, skin of back and sides more or less rugose, hind limbs also to some extent, ventral surfaces smooth, except postero-ventral surfaces of femora.

Color above slate, with brownish gray to dark gray or blackish spots on back and sides, bands or spots on hind limbs; frequently a light band along dorso-lateral folds, and from above axilla below tympanum and eye onto side of head; in some specimens (especially southeastern), a distinct dark stripe extends from orbit through nares to near tip of snout, the light line below encroaching upon the former and not narrowly restricted; ventral surfaces immaculate save for markings about edge of lower jaw; posterior surfaces of femora spotted or reticulated with darker.

*Variations:* The hind leg in some extends as much as the diameter of the orbit in front of the snout, in others only to the orbit; the webs of the hind feet in some leaves only the last and part of the penultimate phalanx free, while in others the three terminal phalanges are free; the length of the head in the total head and body length varies from 3.15 to 4.16 in specimens from one locality, according to age; the head is always as wide as or wider than long, usually the latter, with but few exceptions (southeastern).

*Sexual dimorphism:* The vocal sacs of males are rudimental external or are internal. Their thumbs are enlarged.

TABLE 25  
Measurements of adults

	1	2	3	4	5	6	7
Body length	88.0	69.0	83.0	88.0	77.0	66.3	63.5
Head width	29.5	26.8	28.6	31.7	23.6	21.1	21.0
Head length	26.9	20.7	24.6	27.2	23.4	18.3	20.0
Fore leg	44.0	41.9	47.9	46.0	39.0	40.2	33.0
Femur	42.0	38.0	46.0	48.0	39.0	36.0	34.0
Tibia	53.0	44.5	50.0	53.0	46.0	40.0	37.5
Tarsus	27.0	23.0	26.0	28.0	24.0	20.0	20.0
Foot	47.0	40.0	45.5	49.0	43.0	39.0	34.5
Whole leg	150.0	133.5	148.0	154.0	133.0	120.5	111.5

No. 1 is from Greenwood county (KU 9518); nos. 2-3, Nekoma, Rush county (KU 9551-9552); no. 4, Spring Creek near Walsh's Ranch, Morton county (KU 9557); nos. 5-7, Twin Mounds, Douglas county (KU 9502-9504).

*Description of larvae:* Body more or less egg-shaped from above, slightly dorso-ventrally flattened; greatest diameter of mouth about equal to inter-narial distance, latter somewhat greater than interorbital; nares slightly nearer orbits than end of snout; labial teeth 2/3; lower mandible more or less rounded, v-shaped, upper mandible very flatly u-shaped (inverted); upper

row of labial teeth longest, followed by a row of teeth separated medially by a distance of about  $\frac{3}{4}$  of the length of either half, and about  $\frac{1}{4}$  the length of the upper row; lateral terminations of second row but slightly interior of lateral ends of upper row; in lower labium, the outer row of teeth is shortest, about  $\frac{1}{2}$  the length of the second; second and third of about the same length, sometimes very slightly parted medially; lateral ends of second and third rows of lower labium inner to lateral ends of rows of teeth in upper labium; a row of papillae extending completely around lower labium, and onto edges of upper; an additional row of papillae in corners of lower labium; eye equidistant from spiracle and mouth; spiracular opening rather small, above level of insertion of hind limbs; abdominal skin almost transparent, so that intestines are visible; dorsal crest extending forward of hind legs; tail pointed; ventral crest lesser in diameter than dorsal, latter equal to greatest diameter of tail musculature; greatest diameter of tail including crests at about middle; length of body  $\frac{4}{5}$  that of tail.

No definite color is present in preserved larvae; the tail membranes are very nearly transparent.

*Description of eggs:* Laid in plinth-like masses 4-5 inches in diameter near the surface of the water attached to weed stems, clumps of grass, etc. The jelly is rather firm and compact, with about 4,000 to 6,500 eggs in each mass. There are two envelopes, aside from the vitelline membrane, the outer of which is 2.5 to 3.5 mm. in diameter, the inner 1.5 to 2.0 mm.; the vitellus is about 1.0 to 1.5 mm. The vegetative pole is white, the animal pole brownish, the two distinctly contrasting in life. Eggs of *Rana areolata* are colored somewhat similarly, but the white is less contrasted with the blackish color of the animal pole, the latter encroaching upon the other.

*Song:* In Kansas the song is typically a low chuckling of varied frequency not exceeding 2 or 3 chuckles a second. The sound is scarcely audible, even in a large chorus, more than 150-200 feet away.

*Breeding habits:* Although this species appears very early from hibernation in the spring (I have collected it as early as February 2 in Riley county, and Gloyd [1928] collected them as early as February 16), yet breeding does begin until several weeks later. Gloyd (*op. cit.*) in the same year did not find mated pairs until March 10. In 1933, in Douglas county, they were captured as early as March 11, but did not begin breeding until March 31, even then not reaching the climax of their activity until the middle of April. Egg-laying persists until about the 10th of May, after which time they are seldom heard singing in any numbers.

Certain breeding grounds are sufficiently attractive to harbor rather considerable numbers of breeding pairs. Such a place is described by Gloyd in Pigeon Lake, Miami county:

In many small open spaces among the trees. . . several hundred breeding individuals were gathered together. Some of the breeding grounds were already covered with egg masses. By counting those in about half such an area, the total number of egg masses was estimated at one hundred and fifty.

*Development:* The eggs hatch in about 15-20 days in the field, according to Wright (1914, p. 58), although some under my observation hatched in

the laboratory in five days. Differences in temperature accounts, probably, for this difference in the hatching period, as Wright (loc. cit.) further states that in temperatures of 65-75 degrees, the eggs hatch in from 7-4 or 5 days. The period from egg deposition to larval transformation is about three months long, varying from a little more than two to a little less than four.

**Food:** Drake (1914) has made the most exhaustive study of the food of this species. In adults, the food is practically entirely non-aquatic (about 95%), consisting primarily of arachnids, Hymenoptera, Coleoptera and Hymenoptera. Munz (1920) found that the food of the newly transformed young was much as in adults, with a somewhat lesser proportion of non-aquatic forms.

**Habits and habitat:** The leopard frog is one of the most ubiquitous of the tailless batrachians of Kansas. Practically every roadside pool, stream, pond, lake, swamp and river has its quota, especially during the breeding season and early summer, when transformation takes place. Usually they are most numerous in ponds and swamps.

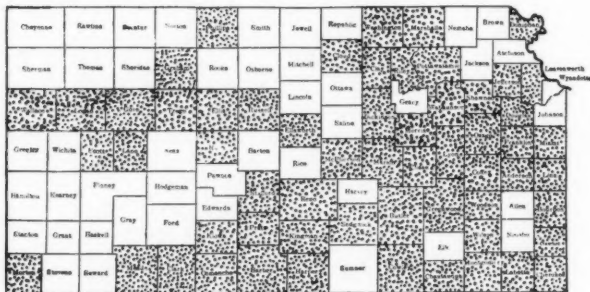
Few others are more wary, as Gloyd (1932, pp. 399-400) states:

When approached, even though slowly and carefully, the eyes disappeared a few at a time as the frogs submerged, for they appeared to detect disturbances in the water at a much greater distance than do toads, bullfrogs, and some other amphibians.

Hibernation, as indicated by Linsdale (1927, p. 77) takes place normally under water in mud, leaves, etc., at a depth great enough to avoid freezing.

Albinos have been reported by Burt and Burt (1929b) from Arizona.

**Distribution:** "North America, east of the Sierra Nevada southward into Mexico." (Stejneger and Barbour, 1923).



Map 23. Distribution of *Rana pipiens* Schreber.

KANSAS: Statewide. Actual records are as follows:

ANDERSON COUNTY: (KU 5031-5052); Hyatt (KU 9406, 9482-9485). BARBER COUNTY: Kiowa (USNM 45379); 7 mi. S. of Sun City (KU, 2 spec.). BOURBON COUNTY: Xenia (USNM 89035). BUTLER COUNTY: 4 mi. W of Leon (KU, 1 spec.). CHASE COUNTY: 5 mi. N of Matfield Green (KU, 1 spec.). CHAUTAUQUA COUNTY: Camp Ta-la-hi 4 mi. SE of Cedarvale (CEB). CHEROKEE COUNTY: Baxter Springs (KSC, 1 spec.). CLARK COUNTY: Englewood, 4 mi. W of (KU, 2 spec.). CLAY COUNTY: Clay Center (USNM 89040); 4 mi. S. of Clifton (Burt and Burt, 1929b). CLOUD COUNTY: Miltonvale (KU 17017-17021). COFFEY COUNTY:

2 mi. W of Lebo (KU, 1 spec.); Neosho River (KU 9519, 9723-9735). COMANCHE COUNTY: 3-4 mi. SE of Arrington (KU, 2 spec.). COWLEY COUNTY: Arkansas City (KU 9451-9452); 7 mi. SE of Winfield (CEB); 5 mi. NW of Winfield (MCZ); Winfield (Munich Mus.); Timber Creek, 4 mi. NE of Winfield (CEB). CRAWFORD COUNTY: Cow Creek, Pittsburgh (KU 9522-9523). DICKINSON COUNTY: Abilene (KSC, 1 spec.). DONIPHAN COUNTY: Doniphan Lake (KU 9422, 9436-9438). DOUGLAS COUNTY: (Boulenger, 1920, p. 441; USNM 57956-58; KU 9489-9490, 9556-9557, 9584-9585, 9614-9615, 1110, 1112, 1441, 7124, 9113-9121, 14044, 14047, 14063-14067, 14070-14071, 14073-14074); Haskell Bottoms (KU 7638-7646, 9549-9550, 9566); Lawrence (KU 9493-9496, 9556, 9514-9515);  $\frac{3}{4}$  mi. N of Lawrence, in Rock Quarries (KU 9810-9833); Rock Creek (KU 9738-9741); Twin Mounds (KU 9502-9504). ELLIS COUNTY: (L. A. Brennan, MS; HMS, 1 spec.). ELLSWORTH COUNTY: (USNM 89055-89056). FRANKLIN COUNTY: (Gloyd, 1928; OU 385-387, 757-764, 777-778; 819; 877); Ottawa (KU 9441-9442); 4 mi. NW of Richmond (Burt and Burt 1929b). GOVE COUNTY: (KU 9555). GRAHAM COUNTY: (KU 9486-7, 9499-9501). GREENWOOD COUNTY: (KU 9518); from pond east of RR at Falls River (KU 9580). HARPER COUNTY: (KU, 1 spec.). JEFFERSON COUNTY: 2 mi. N of Lawrence (KU 9586-9592); 6 mi. N of Lawrence (KU, 2 spec.). KINGMAN COUNTY: 3 mi. W & 4 mi. S of Norwich (KU, 1 spec.). KIOWA COUNTY: 4-5 mi. SE of Belvidere (KU, 1 spec.). LABETTE COUNTY: Big Hill Creek (KU 9554); 3 mi. E of Parsons (CEB). LANE COUNTY: (KU 9470-9474, 9714-9722). LEAVENWORTH COUNTY: State Lake near Tonganoxie (HMS). LINN COUNTY: (KU 9525). LOGAN COUNTY: (KSC 82); Hell Creek Canyon (KU 9553); Smoky Hill River (KU 9456). LYON COUNTY: 15 mi. SW of Emporia (DHD). McPHERSON COUNTY: Lake Inman, about  $4\frac{1}{2}$  miles NE of Inman (CEB). MARION COUNTY: (KU 9683); 2 mi. W of Florence (KU, 1 spec.). MARSHALL COUNTY: 2 mi. W of Waterville, (Burt and Burt, 1929b). MEADE COUNTY: State Lake (HMS). MIAMI COUNTY: (MVZ, 6 spec.; USNM, 4 spec.; UMMZ 66884(4); HKG 603-605); Pigeon Lake (Gloyd, 1932); Ossawatimie (KU 9625-9630); Middle Creek (KU 9492); Marias des Cygnes River (KU 9475-9455). MONTGOMERY COUNTY: (KU 9458-9468).

MORRIS COUNTY: 4 mi. N of Chase-Morris county line, S of Council Grove (KU, 1 spec.). MORTON COUNTY: (Taylor, 1929; KU 9475-9476, 5028, 7113-7123, 7125-7129); Spring Creek W of Rolla (KU 9558); 12 mi. N of Elkhart (KU 9439-9441); Walsh Ranch, 10 mi. N of Elkhart (KU 9770-9786, 9415, 9477-9481). OSAGE COUNTY: (KU 9593). PHILLIPS COUNTY: 3 mi. E of Prairie View (Burt and Burt, 1929b). POTTAWATOMIE COUNTY: Onaga (USNM 45922). PRATT COUNTY: (KU 9743-9764). RENO COUNTY: Medora (USNM 45922); Salt Creek (Yarrow, 1883). RILEY COUNTY: (Dice, 1923; Burt, 1927; HKG 818); Wildcat Creek, just W of Manhattan (KSC 85). RUSH COUNTY: Nekoma (KU 9551-9552). RUSSELL COUNTY: (HMS, 1 spec.). SCOTT COUNTY: State Lake (KU, 1 spec.). SEDGWICK COUNTY: 3 mi. S of Wichita (KU, 1 spec.). SHAWNEE COUNTY: 8 mi. E of Pauline (KU, 1 spec.). STAFFORD COUNTY: (KU 7133); Little Salt Marsh (KU 9736-9737). TREGO COUNTY: (KU 9423-9426, 9582; HMS, 1 spec.). WABAUNSEE COUNTY: 8 mi. NE of Chalk (KU, 1 spec.). WALLACE COUNTY: (KSC 81). WASHINGTON COUNTY: 2 mi. E of Haddam (Nutch's Pond) (Burt and Burt, 1929b); 6 mi. E of Haddam (Burt and Burt, 1929b); 6 mi. N of Haddam (Burt and Burt, 1929b); 3 mi. NE of Haddam (Burt and Burt, 1929b); 5 mi. SE of Haddam (Burt and Burt, 1929b); 1 mi. W of Haddam (Burt and Burt, 1929b); just N of Morrowville (Burt and Burt, 1929b); Washington (Burt and Burt, 1929b); 2 mi. E of Strawberry (Burt and Burt, 1929); 3 mi. E of Palmer (BMNH). WILSON COUNTY: Banks of the Verdigris River, 2 mi. N of Neodesha (KU 9578);  $3\frac{1}{2}$  mi. N of Neodesha (USNM 73317); Verdigris River, 4 mi. NE of Neodesha (Burt and Burt, 1929b). WOODSON COUNTY: Neosho Falls (KU 9410-9411, 9834-9854, 9640-9663).

*History:* The history of *Rana pipiens* in Kansas begins with Hallowell in 1856, who discussed it as *Rana halecina* in his paper on reptiles (and am-

phibians) from Kansas and Nebraska. No definite localities were given. His *Rana pipiens*, as is shown in the "Remarks" in the discussion of *Rana catesbeiana*, is the latter species. A number of years later Cragin (1881) published his account of Kansas reptiles and batrachians, and mentions this species, again without locality records. The first definite locality data are given by Yarrow in 1883, who records a specimen from Salt Creek, Reno county. Cope evidently overlooked the specimen, as it is not mentioned in his work of 1889. Although mentioned by Hartman in 1906, without definite localities, the species is not mentioned again from Kansas until 1920 when Boulenger recorded it from Douglas county. Dice next found it in Riley county, referring to it as "*Rana* sp. Leopard Frog." This is undoubtedly *pipiens*. Since then records have accumulated rapidly: in 1927, Linsdale recorded it from Doniphan county, and Burt, from Riley; in 1928, Gloyd, from Franklin county; in 1929, Taylor, from Morton county, Burt and Burt (b) from Clay, Franklin, Marshall, Phillips, and Wilson counties; and in 1932, Gloyd, from Miami county. Twelve county reports are available from published accounts.

*Remarks:* The Kansas leopard frogs have been variously assigned by different authorities. Cope (1889) considered the western form as *virescens brachycephala*, distinguishing it as follows: "Head shorter and more obtuse, entering the length three and a half times; males without or with rudimentary vocal vesicles; dorsal spots larger, widely yellow-bordered; tibial cross-bands complete; no longitudinal band on the front of the thigh." He further characterized *sphenocephala* as a subspecies of *virescens* ( $= pipiens$ ), a ranking which Dickerson (1913) raised to full specific rank. The subspecies *brachycephala* has long since been thrown into the synonymy of *pipiens*, although it perhaps has some meritorious qualities. *Sphenocephala*, however, has continued to be recognized by most herpetologists, and has been reported in Oklahoma from widely scattered localities over the whole state (Ortenburger, 1926; Ortenburger and Freeman, 1930), while *pipiens* was supposedly restricted to the western portion.

To determine the amount of variation in the Kansas frogs in the characters previously pointed out as diagnostic, a series of measurements and color data were taken on a number of specimens from various localities in the state. The relation of head length to length of head and body was found to be extremely variable, the extremes being 4.15 and 2.92. The proportion here varies directly with size, not geographically, as here shown (the numbers in parentheses are numbers of specimens):

(10) 100-90 mm. ....3.886 times	(10) 59-50 mm. ....3.222 times
(11) 89-90 mm. ....3.745 times	(10) 49-40 mm. ....3.102 times
(17) 79-70 mm. ....3.55 times	(6) 39-30 mm. ....3.02 times
(10) 69-60 mm. ....3.376 times	

This evidence shows conclusively that the relation of the head length to the head and body length is of no value in segregating species of the leopard frog.

The greatest proportional difference of geographic significance is that of the length to the width of the head, as shown below:

Morton county (16) -----	1.16	Woodson county (12) -----	1.0348
Lane county (14) -----	1.20	Montgomery county (11) -----	1.01
Logan county (1) -----	1.13	Labette county (1) -----	1.05
Pratt county (10) -----	1.21	Cleveland county, Okla. -----	1.09
Anderson county (4) -----	1.089		

In some of the larger specimens from Morton and Lane counties the difference between the width of the head and the length was as great as seven millimeters; in only one from the southeastern counties was the difference over 1.5 mm.

Not only are the southeastern specimens more narrow-headed, but the longitudinal bands on the front of the femur was indicated in all by at least a row of spots; the spot on top of the snout in front of the eyes was rarely present; and the distinct bands on each side of the head from the eyes to the tip of the snout were present. In the western specimens the longitudinal femoral band was not even indicated by a row of spots; the spot on top of the snout was rarely present; and there was not distinct bands between the eyes and tip of the snout. A strong tendency toward the southern *sphenocephala* is thus indicated in the *pipiens* of southeastern Kansas. Intergradation is not definitely proved, however, as no typical *sphenocephala* from southern states have been examined, nor specimens from territory intervening between them and Kansas.

#### *Gastrophryne olivacea* (Hallowell)

##### WESTERN NARROW-MOUTHED FROG

*Engystoma olivaceum* Hallowell (1857a, p. 252). Described as new from "Kansas and Nebraska."

*Engystoma carolinense* (nec Holbrook) Cragin (1881, p. 119). "Kansas."

Cope (1889, pp. 385-386, fig. 97). (part.)

*Engystoma texense* Strecker (1909b, pp. 115-120). Habits and discussion of relationships.

Dickerson (1913, pp. 168-169).

*Gastrophryne carolinensis* (nec Holbrook) Dice (1923, pp. 46-52). Recorded from Riley county.

Burt (1927, p. 3). Recorded from Riley county.

Linsdale (1927, p. 77). Recorded from Doniphan county.

*Gastrophryne texensis* Strecker (1926b, p. 12). Notes on life history.

Wright (1929, pp. 13-14, pl. 6, fig. 3). Description of larvae.

Wright (1931, pp. 475-476). Discussion of relationships.

Type locality: "Kansas and Nebraska."

**Diagnosis:** A *Gastrophryne* with slate gray upper parts, usually with some indefinitely outlined small black spots concentrated on mid-dorsal region and hind quarters; ventral surfaces white, immaculate, occasionally with very faint reticulations in gular region and on sides; skin smooth.

**Comparisons:** *Gastrophryne olivacea* differs from all other Kansas anurans in the absolute absence of webs between the toes; it is also the only one in which the tympanum is entirely concealed. The absence of teeth in the upper jaw distinguishes it from all but *Bufo*, which is characterized in all Kansas species by prominent parotid glands.

From *carolinensis*, *olivacea* differs largely in color, the southeastern species



being usually brownish above, sometimes reticulated with darker brown, and at other times with an indistinct broad band on the back, extending from the post-orbital region to the hind legs, about as broad as the interorbital distance anteriorly, gradually widening posteriorly until at the groin it covers  $\frac{3}{4}$  of the back. This particular marking is very suggestive of *Gastrophryne elegans* of Mexico and Central America. The ventral surfaces of *carolinensis* are distinctly reticulated with light brown.

*Hypopachus*, a genus of brevicipitid frogs represented in Texas by the single species *cuneus*, differs from *Gastrophryne* in possessing slight webs between the toes and a large outer metatarsal tubercle (a small one rarely present in *carolinensis*).

*Description*: Head flat, top slightly convex; internarial distance about equal to or slightly less than orbitonarial distance, about  $\frac{2}{3}$  of interorbital distance; nares very near tip of snout, opening laterally; greatest diameter of orbits about equal to orbitonarial distance; a transverse groove passing across head between posterior borders of orbits and extending onto each side of the head behind angles of jaws, and sometimes completely encircling the head; angle of jaws below posterior margin of orbit; snout pointed, nares anterior to lower jaw in lateral profile; tongue long, round at posterior margin; symphysis of lower jaw with a median projection bordered on each side by a shallow notch; internal nares at anterior margin of oral cavity, a soft palate projecting partially over them; skin of body not extending out onto humerus; fingers not webbed, subarticular tubercles distinct; metacarpal tubercles two or three, one at base of second finger, another at base of the fifth and the other between, sometimes the two latter fused; fingers 2-3-5-4 in order of increasing length, toes 1-2-5-3-4; latter not webbed, subarticular tubercles distinct; inner metatarsal tubercle present, with no free edges; outer metatarsal tubercle absent; no tarsal fold; a groove across chest between axillae; tibiotarsal articulation touching or slightly overlapping, extending forward to between axilla and orbit.

Color slate or brownish gray above, either uniform or with a few black spots scattered over back and hind legs; ventral surfaces whitish, immaculate or with very faint reticulations of darker in gular region and on sides; concealed surfaces of femora and groin uniform slate to whitish.

*Sexual dimorphism*: The throats of males are black. There is apparently no difference in the development of the second finger.

TABLE 26  
Measurements of adults

	1	2	3	4	5	6	7
Body length	30.5	31.0	32.6	29.4	27.5	36.5	29.8
Width of head	7.9	9.0	8.8	8.2	8.6	9.5	8.8
Fore leg	13.8	13.8	14.5	12.4	12.1	15.1	13.9
Femur	11.0	11.0	11.9	10.5	10.0	12.5	10.8
Tibia	10.8	11.0	12.0	10.3	10.0	12.5	11.0
Tarsus	7.2	7.3	8.0	7.0	7.0	8.0	7.0
Foot	13.2	13.0	13.3	12.0	12.0	14.7	13.0
Hind leg	38.0	37.8	41.0	36.5	34.5	41.5	37.0

Nos. 1-5 are from Midland, Douglas county (KU 7878-7882); no. 6, Independence, Montgomery county (KU 9897); no. 7, Garnett, Anderson county (KU 9895).

*Larvae:* Described by Wright (1929, pp. 13-14).

*Eggs:* Strecker (1926, p. 12) remarks that:

The egg mass of the Texas toothless frog or toad. . . is oblong and irregular in outline. The eggs are light brown with white vegetative pole. Size, less than that of a number eight shot (about one millimeter). The number ranges from 100 to 200 in a mass. The mass is attached to weed stems in from four to eight inches of water. I do not think that there are more than two or three emissions from one female.

Wright (1929) states:

Outer egg envelope not truncate, mass seldom showing distinct outline of each egg envelope in a mosaic fashion.

*Song:* The breeding call is a high, shrill buzz of some 2-3 seconds duration, and of such slight volume that a single call cannot be heard more than fifty to a hundred feet away. A full chorus sounds like a band saw in operation.

*Breeding habits:* Little seems to have been recorded of the breeding habits of this frog. Dickerson (1913, p. 169) remarks that they were found breeding during late June in 1905 near Brownsville, Texas. In early September of 1932 I heard large choruses in the same region. The season in Kansas may be extremely late, as a female collected during August of 1926 in Montgomery county near Independence retained large numbers of eggs in her abdomen. Other females collected as late as June 16 near Manhattan contained eggs.

Amplexation is presumably axillary, as in *G. carolinensis*.

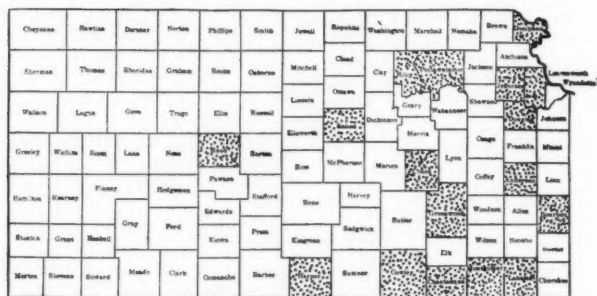
*Food:* The food apparently consists almost entirely of ants. A number of specimens from numerous widely scattered localities in Kansas contained nothing in their stomachs aside from large numbers of small ants.

*Habits and habitat:* As Dice (1923), who found this species in the Rocky-ground community and Hillside forest community of Riley county, indicates, this species of frog in Kansas is far more characteristic of terrestrial than of aquatic habitats. Of the numerous specimens I have collected or seen collected near Manhattan, all were from the communities mentioned by Dice (*op. cit.*). The usual cover is rocks. Wright (1931) remarks that the eastern species, *carolinensis*, is subterranean, and quite possibly *olivacea* is also. The burrowing adaptations are carried to a still higher development in *Hypopachus*, which has two metatarsal tubercles with free cutting edges which would be of much value in burrowing as in *Scaphiopus* and certain species of *Bufo*.

*Distribution:* Texas north to Kansas, east to western Missouri and Arkansas, south through northern Mexico.

KANSAS: Probably over the entire eastern and central part of the state. Actual records are as follows:

ANDERSON COUNTY: Garnett (KU 9895). BOURBON COUNTY: (USNM 73647-73648; FMNH, 2 spec.; UMMZ 66866(3), 1 spec.; OU 961-962). CHASE COUNTY: Elmdale (EHT, 1 spec.). CHAUTAUQUA COUNTY: Camp Ta-la-hi 4 mi. SE of Cedarvale (USNM). COWLEY COUNTY: 8 mi. NE of Winfield (CEB). DONIPHAN COUNTY: (Linsdale, 1927). DOUGLAS COUNTY: (KU 7877-7882); 3 mi. W of



Map 24. Distribution of *Gastrophryne olivacea* (Hallowell).

Lawrence (KU 9896); 5½ mi. NW of Lawrence (KU 9893-9894); Lawrence (KU 9938-9948). GREENWOOD COUNTY: 1 mi. W. of Eureka (KU, 2 spec.). HARPER COUNTY: 5 mi. S of Harper (KU, 1 spec.). JEFFERSON COUNTY: (KU 14537-14038); 10 mi. NW of Lawrence (KU 14575-14584). LABETTE COUNTY: 12 mi. SW of Oswego (KU 9904). LEAVENWORTH COUNTY: (KU 3478-3482). MONTGOMERY COUNTY: Independence (KU 9897; USNM 62258). POTTAWATOMIE COUNTY: (UMMZ 66868(7)). RILEY COUNTY: (Dice, 1923; Burt, 1927; KU 7869); Manhattan (KSC 73-78; FMNH, 2 spec.; UMMZ, 1 spec.; MVZ, 2 spec.; CAS, 3 spec.; PC, 3 spec.; UMMZ 66867(9); Ogden (CAS, 8 spec.); Bluffs above Wildcat Creek, just west of Manhattan (USNM 73321-73322). RUSH COUNTY: Nekoma (KU 9905-9912). SALINE COUNTY: 10 mi. E of Salina (KU, 12 spec.).

*History:* Hallowell reported this species from Kansas first, when describing his *Engystoma olivaceum* from "Kansas and Nebraska," in 1857. Cragin reported the same thing in 1881 as *carolinensis*, probably basing his judgment upon the fact that Cope (1875) recognized but the latter species, although both *E. olivaceum* and *E. texense* Hallowell, 1860, had been described. All recent authors have used the same appellation for the Kansas *Gastrophryne*, Dice reporting it from Riley county in 1923, Burt from the same locality in 1927, and Linsdale from Doniphan county in 1927. Two published county reports are thus available.

*Remarks:* The confusion in the proper name for the *Gastrophryne* of Kansas and the territory to the south of that state is largely due to the immediate relegation of *E. olivaceum* into the synonymy of *E. carolinensis*, or complete ignoring of it, by Cope (1875; 1880; 1889) and Yarrow (1883). Whatever the cause, Cragin (1881) accepted the description as a record of *carolinensis*, and all recent writers on Kansas herpetology have followed his example. Not only did Cope, and Yarrow (*op. cit.*) neglect or synonymize *olivaceus*, but they did the same with *texense*, described from Rio Seco, Texas, by Girard (1860). Dickerson (1913) and Strecker (1909b) have shown that the latter species is distinct from *carolinensis*, but not until very recently has it been shown that the species in Texas is the same as the species in Kansas. With this interpretation, Hallowell's *E. olivaceum* no longer can be

known as a synonym of *E. carolinense*. On the contrary, since it was described three years before *texense*, *olivaceum* claims priority.

The adoption of the generic term *Gastrophryne* to replace *Engystoma* is explained by Stejneger (1910). Thus, *Engystoma olivaceum* becomes *Gastrophryne olivacea* (Hallowell).

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## PLATE XII

- Fig. 1. Larval mouthparts of *Scaphiopus bombifrons*, from a tadpole collected near Grant, Valencia county, New Mexico. x 10
- Fig. 2. Egg of *Pseudacris triseriata*, from a mass laid in the field, near Haskell Bottoms, Douglas county, Kansas. x 5
- Fig. 3. Egg of *Acris gryllus* laid in the laboratory by a female collected near Lakeview, Douglas county, Kansas. x 5
- Fig. 4. Egg of *Ambystoma texanum* laid in the laboratory by a female from Haskell Bottoms, Douglas county, Kansas. x 5
- Fig. 5. Egg of *Rana pipiens*, from a mass collected three miles north of Clay Center, Clay county, Kansas. x 5
- Fig. 6. Egg of *Ambystoma texanum*, collected as laid in the field, in Haskell Bottoms, Douglas county, Kansas. Shows a slight difference from eggs laid in the laboratory, as indicated in fig. 4. x 5
- Fig. 7. Egg of *Rana areolata*, from a mass collected in Haskell Bottoms, Douglas county, Kansas. x 10
- Fig. 8. Larval mouthparts of *Bufo debilis* (?), from a tadpole collected near the head of Schwartz Canyon, a tributary of Indian Creek, Comanche county, Kansas. x 20
- Fig. 9. Egg of *Ambystoma tigrinum mavortium*, from eggs laid in the field eight miles west of Clay Center, Clay county, Kansas. x 5
- Fig. 10. A portion of the egg bands of *Bufo w. woodhousii*, from eggs laid in the laboratory by a female collected near Lakeview, Douglas county, Kansas. x 5
- Fig. 11. A portion of the egg bands of *Bufo a. americanus*, from eggs laid in the laboratory by a female collected near Lakeview, Douglas county, Kansas. x 5

## PLATE XIII

- Fig. 12. Larva of *Ambystoma tigrinum mavortium*, hatched from eggs collected eight miles west of Clay Center, Clay county, Kansas. x 10
- Fig. 13. *Ambystoma maculatum*, adult. KU 4019, from Lewisville, Lafayette county, Arkansas. Reduced 1/5.
- Fig. 14. *Ambystoma tigrinum mavortium*, adult. From 18 miles north of Elkhart, Morton county, Kansas. Reduced 1/5.

## PLATE XIV

- Fig. 15. *Eurycea melanopleura*, adult. From Ravenden, Lawrence county, Arkansas. Reduced 1-3.
- Fig. 16. *Ambystoma texanum*, adult, dorsal surface. From Haskell Bottoms, Douglas county, Kansas. About natural size.
- Fig. 17. Same, ventral surface.

#### PLATE XV

- Fig. 18. *Bufo cognatus*, adult. From 9 miles north of Tribune, Greeley county, Kansas. Slightly reduced.
- Fig. 19. *Triturus viridescens louisianensis*, male (left) and female. KU 14767-14768, from Imboden, Lawrence county, Arkansas. Reduced  $\frac{1}{4}$ .

#### PLATE XVI

- Fig. 20. *Bufo debilis*, adult. KU 5647, 18 miles north of Elkhart, Morton county, Kansas. Enlarged  $\frac{1}{2}$ .
- Fig. 21. *Bufo punctatus*, adult. KU 11970, from near Grant, Valencia county, New Mexico. Natural size.

#### PLATE XVII

- Fig. 22. *Bufo w. woodhousii* (left) and *Bufo a. americanus*, ventral surfaces of adults. Former from 35 miles southeast of Meade county state park, Meade county, Kansas. Latter from 1 mile southwest of Carbondale, Osage county, Kansas. Reduced slightly over  $\frac{1}{2}$ .
- Fig. 23. Same, dorsal surfaces.

#### PLATE XVIII

- Fig. 24. *Pseudacris clarkei*, adult. From 2 miles north of Lexington, Cleveland county, Oklahoma. Natural size.
- Fig. 25. Same.
- Fig. 26. *Hyla crucifer*, adult. KU 10565, from Starbrick, four miles north of Warren county, Pennsylvania. x 2
- Fig. 27. *Pseudacris triseriata*, adult. KU 13649, from Ottawa, Franklin county, Kansas. Enlarged  $\frac{1}{3}$ .

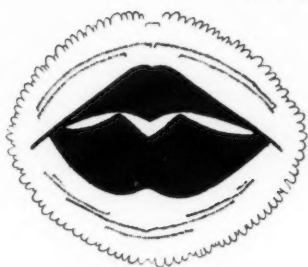
#### PLATE XIX

- Fig. 28. *Hyla versicolor versicolor*, adult. Pigeon Lake, Miami county, Kansas. Photographed by H. K. Gloyd.
- Fig. 29. *Rana palustris*, adult. KU 7883, from St. Clair county, Illinois. Slightly enlarged.

#### PLATE XX

- Fig. 30. *Gastrophryne olivacea*, adult. KU 9908, from Nekoma, Rush county, Kansas. Enlarged  $\frac{12}{5}$  times.
- Fig. 31. *Rana areolata*, adult. Haskell Bottoms, Douglas county, Kansas. Photographed by Dr. E. H. Taylor. About natural size.

PLATE XII



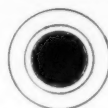
1. *S. bombifrons*



2. *P. triseriata*



3. *A. gryllus*



4. *A. texanum*



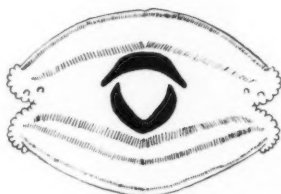
5. *R. pipiens*



6. *A. texanum*



7. *R. areolata*



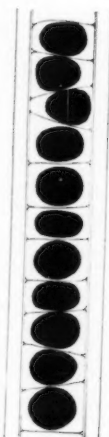
8. *B. debilis?*



9. *A. t. mavortium*



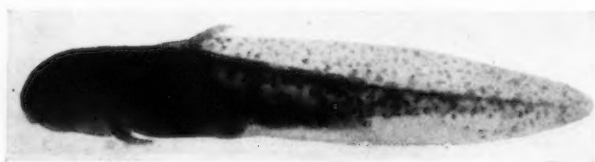
10. *B. w. woodhousii*



11. *B. a. americanus*



PLATE XIII



12. *A. t. mavortium*



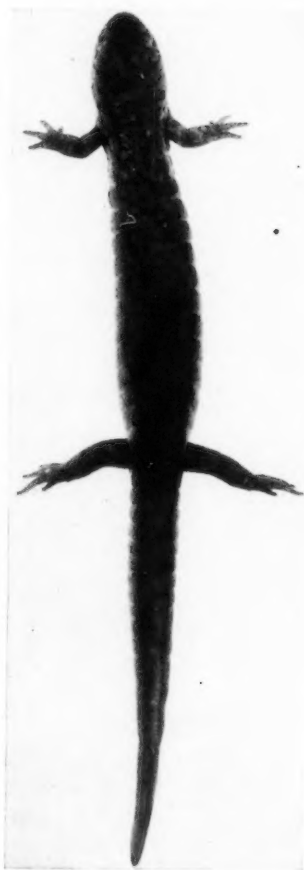
13. *A. maculatum*

14. *A. t. mavortium*

PLATE XIV



15. *E. melanopleura*



16. *A. texanum*

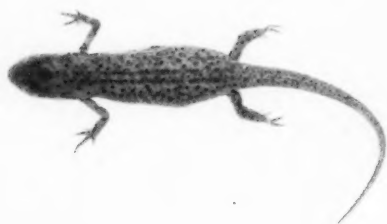


17. *A. texanum*

PLATE XV



18. *B. cognatus*



19. *T. v. louisianensis*



PLATE XVI

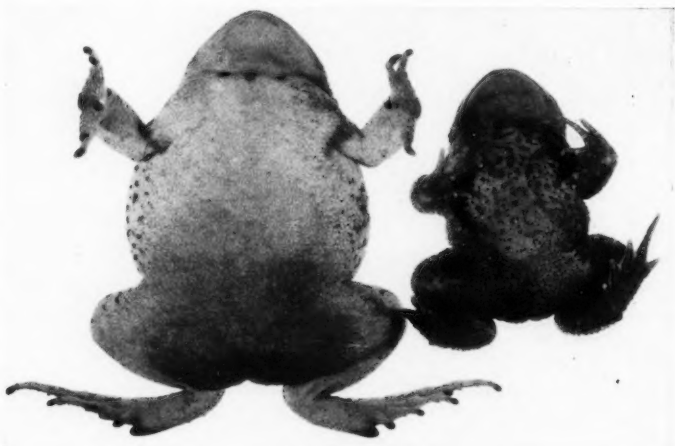


20. *B. debilis*

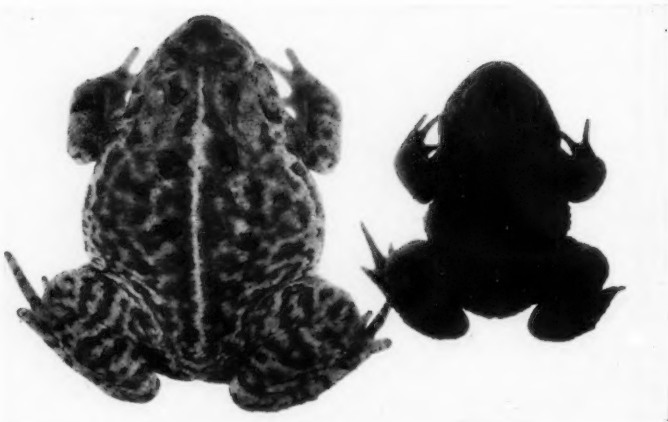


21. *B. punctatus*

PLATE XVII



22. *B. w. woodhousii* and *a. americanus*



23. *B. w. woodhousii* and *a. americanus*

PLATE XVIII



24. *P. clarkii*



25. *P. clarkii*



26. *H. crucifer*



27. *P. triseriata*

PLATE XIX



29. *R. palustris*



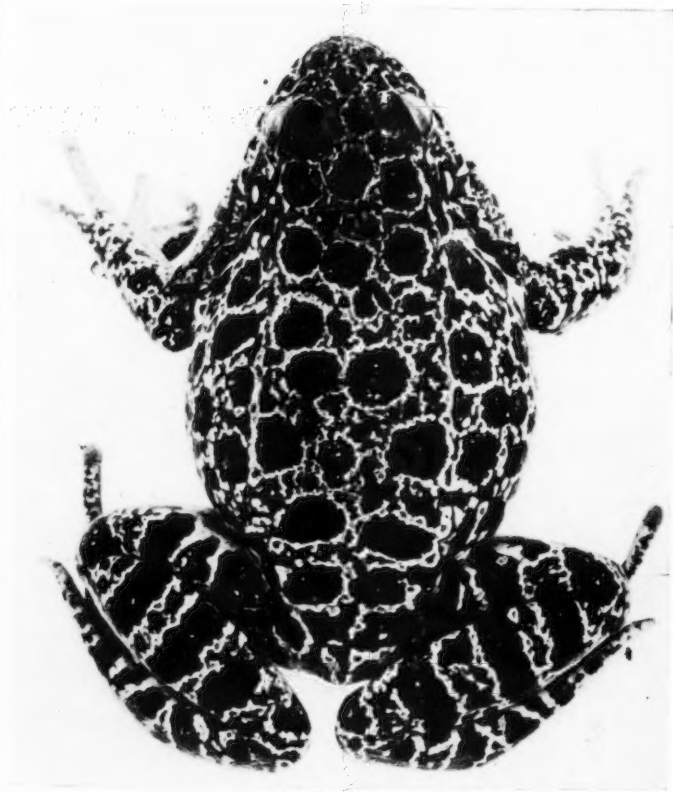
28. *H. v. versicolor*



PLATE XX



30. *G. olivacea*



31. *R. areolata*

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